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Printed on Thin Paper for Foreign Circulation.

"THE ENGINEER" FEBRUARY 26, 1926.

With METALLURGICAL SUPPLEMENT.

The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXLI.—No. 3661] LONDON: FRIDAY EVENING, FEBRUARY 26, 1926 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—

1. 23 ELECTRIC PASSENGER LOCOMOTIVES.
2. ELECTRICAL EQUIPMENTS for 15 MOTOR COACHES and 42 TRAILER COACHES.

Tenders due on the 13th April, 1926, before 2 p.m., for No. 1, and on the 23rd April, 1926, before 2 p.m., for No. 2.

Specification and form of Tender obtainable from the above at a fee, which will not be returned, of in each case £2 for the first three copies and £1 for each further copy. 1677

Assistant Engineers (Surveyors) (2) REQUIRED by the GOVERNMENT of the TANGANYIKA TERRITORY for the RAILWAY DEPARTMENT for a tour of 20 to 30 months, with possible extension. Free passages and liberal leave on full salary. Salary £600 a year plus a consolidated field allowance of £160 a year whilst discharging duties in the Territory. Candidates, not over 40 years of age, must be fully qualified Railway Engineers with a full knowledge of barometric, tacheometric and location work, must be good draughtsmen, able to produce neat large and small maps. Must have a full knowledge of instruments and be able to repair minor damages in the field, preferably should have been Railway Surveyors in unmapped tropical countries.—Apply at once by letter, giving brief details of experience and qualifications, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/14,229. 1742

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Thursday, 11th March, 1926, for the INSTALLATION of ACCELERATED LOW-PRESSURE HOT WATER HEATING at Nottingham Employment Exchange.

Drawings, specification, a copy of the conditions and form of contract, bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners of H.M. Works, &c.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 1711

London Association of Foremen ENGINEERS.
Established 1852.

Foremen, Managers and Employers connected with Engineering Industry.

OBJECTS.

The relief of distress arising from Unemployment, Infirmity, Old Age or Death.

The reading of Papers, and promoting an exchange of opinions on matters connecting with the various branches of Engineering.

Applicants for Ordinary Membership must be under 45 years of age and have held the position of Manager, Foreman or Leading Draughtsman in a branch of engineering.

Terms of Membership.

Honorary Life Members	£10	10	0
Honorary Annual Members, per annum	£1	11	6
Ordinary Members, per annum	£4	0	0
Exit Fee	£2	2	0

SEVENTY-THIRD ANNIVERSARY FESTIVAL, SATURDAY, MAY 8th, 1926, Cannon Street Hotel, London, E.C.
President: Viscount Chetwynd.

Application forms for membership apply, SECRETARY, 83, Salisbury-road, Harrow. 1689

Crystal Palace School of Practical Engineering.
Founded 1872.
MECHANICAL AND CIVIL ENGINEERING DIVISIONS.

PRESIDENT: J. W. WILSON, M.I.C.E., M.I.M.E.
PRINCIPAL: MAURICE WILSON, M.I.C.E.
Assisted by Staff of Lecturers and Instructors.
Thorough, up-to-date Practical and Theoretical Instruction. Course completed in 2 years
Students admitted at beginning of any term. 1171

Bangor (County Down) Urban DISTRICT COUNCIL.
QUARRY PLANT WANTED.

The above Council invites TENDERS for a STONE-BREAKER, GRANULATOR, and OIL ENGINE, in accordance with specification which can be obtained at the Council's offices.

Tenders will be received by me up to Twelve Noon on Friday, 19th March, 1926.

The Council does not bind itself to accept the lowest or any Tender.

J. MILLIKEN,
Clerk to the Council.

Town Hall, Bangor, Co. Down,
17th February, 1926. 1687

The South Indian Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for the SUPPLY of :—

1. STEEL BEARING PLATES for F.B. RAILS.
2. POINTS and CROSSINGS.
3. SPARE PARTS of LOCOMOTIVE ENGINES.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Steel Bearing Plates," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 12th March, 1926.

The Directors do not bind themselves to accept the lowest or any Tender.

A charge, which will not be returned, will be made of 2s. 6d. for each copy of Specification No. 1, of 10s. for each copy of Specification No. 2, and of £1 for each copy of Specification No. 3.

Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster.

W. B. REYNOLDS,
For Managing Director.

91, Petty France, S.W. 1,
24th February, 1926. 1741

The Engineer

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PUBLIC NOTICES

City of Wakefield Waterworks, RYBURN SCHEME.
CONTRACT NO. 4.—STEEL PIPES.

The Corporation invite TENDERS for the SUPPLY of 725 FEET of 22in. internal diameter and 11,001 FEET of 20in. internal diameter STEEL PIPES, lined with bitumen tin, thick, centrifugally applied, including SPECIAL PIPES for River, Railway, and other Crossings.

Specification, conditions of contract, forms of Tender, and other particulars may be obtained from, and drawings may be seen, at the office of C. Clemesha Smith, M. Inst. C.E., Waterworks Engineer, Town Hall, Wakefield, on and after Friday, February 26th, 1926, on payment of a deposit of Two Guineas, which will be returned on receipt of a bona fide Tender and the documents supplied.

The Corporation do not bind themselves to accept the lowest or any Tender.

Tenders, endorsed "Steel Pipes," to be delivered to me not later than Twelve Noon on Monday, March 15th, 1926.

A. C. ALLIBONE,
Town Clerk.

Town Hall, Wakefield,
22nd February, 1926. 1702

Farnham Urban District Council UNEMPLOYMENT RELIEF WORKS.
CONTRACT NO. 3.
MAIN DRAINAGE.
TO CONTRACTORS.

The Farnham Urban District Council are prepared to receive TENDERS for the ERECTION of TWO PUMPING STATIONS, together with SUCTION TANKS and other appurtenant WORKS, in accordance with the plans and specification prepared by the Engineer, Mr. G. Midgley Taylor, of Messrs John Taylor and Sons, Caxton House, Westminster, S.W. 1.

Copies of the specification, bill of quantities, and form of Tender may be obtained, and the drawings may be seen, at the offices of the Engineer upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Sealed Tenders, endorsed "Farnham Drainage, Contract No. 3," addressed to the undersigned at his office at Farnham, must be received before Noon on Saturday, the 13th day of March, 1926.

Any contract or contracts entered into will include the usual fair wages and conditions of labour clause and special conditions as to engaging unemployed men from the local Labour Exchange.

The Council do not bind themselves to accept the lowest or any Tender.

By Order,
J. W. WRIGHT,
Clerk.

Council Offices,
Farnham, Surrey. 1718

PUBLIC NOTICES

Farnham Urban District Council UNEMPLOYMENT RELIEF WORKS.
CONTRACT NO. 4.
OUTFALL WORKS.
TO CONTRACTORS.

The Farnham U.D.C. are prepared to receive TENDERS for the CONSTRUCTION of SEWAGE TREATMENT WORKS, consisting of Settlement Tanks, Percolating Filters, Humus Tanks, Sludge and Humus Beds, and other Works on their existing Sewage Farm, in accordance with the plans and specification prepared by the Engineer, Mr. G. Midgley Taylor, of Messrs. John Taylor and Sons, Caxton House, Westminster, S.W. 1.

Copies of the specification, bill of quantities, and form of Tender may be obtained, and the drawings may be seen, at the offices of the Engineer upon payment of £5 (cheque only), which will be returned upon receipt of a bona fide Tender.

Sealed Tenders, endorsed "Farnham Drainage, Contract No. 4," addressed to the undersigned at his office at Farnham, must be received before Noon on Saturday, the 13th day of March, 1926.

Any contract or contracts entered into will include the usual fair wages and conditions of labour clause, and special conditions as to engaging unemployed men from the local Labour Exchange.

The Council do not bind themselves to accept the lowest or any Tender.

By Order,
J. W. WRIGHT,
Clerk.

Council Offices,
Farnham, Surrey. 1719

City of Nottingham. WATER DEPARTMENT.
TO PAINTERS.

The Water Committee invite TENDERS for PAINTING the SUSPENSION BRIDGE over the River Trent.

Specifications, bills of quantities, and form of Tender may be obtained on application to Mr. F. W. Davies, Engineer and General Manager, Water Offices, Castle Boulevard, Nottingham, accompanied by a deposit of One Guinea, which will be refunded on receipt of a bona fide Tender.

Sealed Tenders, endorsed "Tenders for Painting Suspension Bridge," to be sent to me at the Guildhall, Nottingham, not later than Noon on Monday, March 15th, 1926.

The Water Committee do not bind themselves to accept the lowest or any Tender.

By Order,
W. J. BOARD,
Town Clerk.

Guildhall, Nottingham,
February 24th, 1926. 1725

PUBLIC NOTICES

Royal Show.

READING

JULY 6th to 10th, 1926.

EXHIBITION OF IMPLEMENTS, &c.

The Regulations and Forms of Application for Space are now ready.

Applications must be made by

SATURDAY, MARCH 20th, 1926

Live Stock entries close on MAY 1st; Produce and Forestry on MAY 20th; Horticulture on MAY 26th; Poultry on MAY 31st; Competitions for Plantations, Home Nurseries, Orchards and Fruit Plantations on MAY 1st.

T. B. TURNER, Secretary.

ROYAL AGRICULTURAL SOCIETY OF ENGLAND,
16, Bedford Square, London, W.C. 1.

Holborn Union, London.
ENGINEER REQUIRED at the Holborn and Finsbury Hospital, Archway-road, N.

Wages £5 a week, with house, coal and lighting, valued for superannuation purposes at £1 a week.

Candidates must be competent to take charge of the Steam Plant and Electric Lighting Installation, and the person to be appointed will be required to devote his whole time to the duties of the appointment.

Application forms may be obtained on application to the Steward of the Hospital, and must be returned to him not later than Wednesday, the 10th March, 1926.

By Order,
CHAS. J. CROSS,
Clerk to the Guardians.

Administrative Offices :
53, Clerkenwell-road, E.C. 1,
20th February, 1926. P1641

The Assam-Bengal Railway COMPANY, LIMITED.
ASSISTANT CIVIL ENGINEERS.

REQUIRED for service on the above Railway, TWO ASSISTANT CIVIL ENGINEERS, who must have had a good general and technical education at a recognised Engineering College, and obtained a degree or passed the A.M. Inst. C.E. Examination, and thereafter have had not less than one year's practical experience with a Railway Company or on Public Works in Great Britain.

SALARY.—Rupees 525 per calendar month.

TERMS.—A three years' agreement in the first instance and first-class free passage to India.

The selected candidate will be required to pass a strict medical examination before appointment.

Applications (by letter only), giving full particulars of candidates' general and technical education, and showing in chronological order (with dates) where such has been obtained, together with details of practical experience, &c., must be addressed to the undersigned not later than 6th March, 1926.

By Order of the Board,
OSWALD I. MILNE,
Secretary.

19th February, 1926.
Bishopsgate House,
80, Bishopsgate, E.C. 2. 1678

The Fire Salvage Association of Liverpool, Limited, is prepared to receive APPLICATIONS for the POSITION of SUPERINTENDENT at their Chief Station. Commencing salary £400 per annum, with house, &c., and good prospects of promotion.

Applicants must not be over 35 years of age and must possess engineering qualifications as well as experience in handling men.

Replies, stating age, height, qualifications and experience, to be addressed to the CHIEF OFFICER, Fire Salvage Association of Liverpool, Limited, 16, Hatton-garden, Liverpool.

Canvassing in any form will disqualify. 1648

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PUBLIC NOTICES

City of Karachi (India).

APPOINTMENT OF CHIEF OFFICER.

The Municipal Council of the City of Karachi invite APPLICATIONS for the APPOINTMENT of CHIEF OFFICER.

The Chief Officer is required on behalf of the Municipality to conduct all general correspondence, keep minutes of proceedings, supervise the accounts, collection of revenue, and expenditure, exercise control over the staff and departments subordinate to him, and to perform all the administrative duties as prescribed by the Municipal Act and Rules.

Applicants must produce evidence of a good general education, must possess an intimate knowledge of municipal administration in all its branches, and preference will be given to applicants who have had experience and held responsible positions in a municipal or other similar public office, with a fairly good knowledge of engineering.

The selected candidate will be required to furnish a medical certificate of sound health prior to his engagement.

The appointment will in the first instance be for one year on probation, and if confirmed for satisfactory work, he will be required to execute an agreement for a further period of four years, and thereafter for renewable periods of five years.

The salary of the post is Rs. 1100, rising by annual increments of Rs. 50 to Rs. 1400, plus Rs. 150 motor car allowance.

The holder of the appointment is required to subscribe to the Municipal Provident Fund, and he will be entitled to leave and pension in accordance with the Municipal Rules in force from time to time.

The salary will commence from the date of joining the appointment in Karachi, but a single first-class steamer or rail fare to Karachi will be paid.

Canvassing or the forwarding of letters of recommendation to the President or Councillors will make the applicant liable to disqualification.

Applications, stating age, qualifications and experience, together with recent photos and with copies of recent testimonials (which will not be returned), to be sent to the President, Municipal Office, Karachi, India, not later than 15th April, 1926.

For reference to municipal leave, pension and Provident Fund Rules, see personally Messrs. John Taylor and Sons, Caxton House, Westminster, S.W.1, London (England).

JAMSHED N. R. MEHTA,
President,
Karachi Municipality.

Karachi, 30.1.1926. 1734

Western Australia.

APPLICATIONS are INVITED by the Agent-General for Western Australia for the following POSITIONS in the Public Works Department of the Western Australian Government :—

ASSISTANT ENGINEER, with good experience in Design and Construction of Harbour and Dock Works. Salary £600 per annum.

ASSISTANT ENGINEER, experienced in Design large Water Supply Works, Dams and Reservoirs; must be capable Draughtsman. Commencing salary £408, rising to £480 per annum.

ASSISTANT ENGINEER, experienced in Design of large Draining Canals, Irrigation and Hydraulic Work generally; must be capable Draughtsman. Commencing salary £408, rising to £480 per annum.

DRAUGHTSMAN, experienced in Design Hydraulic Works, particularly Dams, Reservoirs, and Pipe Lines; must also be capable Reinforced Concrete Designer. Commencing salary £408 per annum.

Transport allowance: Single man, £75; married man, £150; married man with family, £300. Salary to commence from the date of taking up duty in Western Australia. Should the successful applicants voluntarily relinquish their respective positions before the expiration of 2 years from the date of appointment, they will be called upon to refund the amount of transport allowance.

Applicants must state age and whether married or single.

Applications, accompanied by testimonials or references, must reach the AGENT-GENERAL FOR WESTERN AUSTRALIA, Savoy House, 115/116, Strand, London, W.C. 2, not later than 31st March, 1926. 1727

Egyptian State Railways, Telegraphs and Telephones.

THE EGYPTIAN STATE RAILWAY ADVERTISER

A weekly publication in Arabic, English and French.

Subscription: 30 Egyptian Piastres (about 10 shillings and sixpence) yearly.

An organ of the Egyptian State Railways, Telegraphs and Telephones, containing information of interest to Contractors and Suppliers of Materials and Stores used by the Administration.

For particulars apply to PUBLICITY SECTION, Egyptian State Railways, Cairo, (Egypt). 1170

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, a SALESMAN for Yorkshire; Must be an Engineer with Steam and Hydraulic experience.—Write, E57, Birchall's Advertising Offices, Liverpool. 1609 A

WANTED, an ASSISTANT ENGINEER for Work in connection with Sewage Disposal Works. The appointment is a temporary one and is at the inclusive rate of £350 per annum.—Applications, stating age, qualifications and previous experience, and enclosing copies of three recent testimonials, to be sent to the CITY ENGINEER, Town Hall, Manchester, not later than 10 a.m. on Wednesday, 10th March, 1926. 1724 A

WANTED, ASSISTANT MANAGER by Firm of General Engineers in the Midlands. Works include Pattern Shop, Foundry, Boiler Shop, Machine and Fittings Shops.—Address, giving full particulars as to experience and salary required, P1619, The Engineer Office. P1619 A

WANTED by Firm of Consulting Waterworks Engineers in Westminster, DRAUGHTSMAN, with first-class experience in design of Civil Engineering Works and Building Construction. Age about 35. Salary £30 per month.—Write, stating experience, to Box 2248, c/o Brown's, 39, Tothill-street, S.W. 1. 1674 A

WANTED for India, an ENGINEER, Public School man, with thorough knowledge of Sales and Erection of Pumping Machinery and with electrical training. State age, experience, and salary.—Address, 1690, The Engineer Office. 1690 A

ASSISTANT BUYER REQUIRED for Engineering Works, S.W. London. Previous experience essential. State age, salary, &c.—Address, P1611, The Engineer Office. P1611 A

ASSISTANT REQUIRED for Design and Estimating Department of London Constructional Engineers. Similar experience essential; also thorough knowledge of London Building Acts.—Address full particulars, age, experience, salary, 1723, The Engineer Office. 1723 A

ASSISTANT WORKS MANAGER REQUIRED for Large Plant manufacturing Lap-welded Tubes by water gas process. Must be good organiser and have thorough knowledge of the trade. State experience and salary.—Address, 1617, The Engineer Office. 1617 A

BELGIUM.—An Important BELGIAN WORKS, producing Engineers' Small Tools (Twist Drills, Reamers, Screw Taps and Dies, &c.), REQUIRES the SERVICES of an ENGINEER, capable of taking entire responsibility for the Technical and Commercial Management. Applicants must be able to prove from previous experience in similar positions that they are capable of filling this post with success. A good knowledge of the French language is desirable.—Applications, with age, education, particulars of experience, copies of references, and salary required, should be sent to P1625, The Engineer Office. P1625 A

CONTRACT ENGINEER REQUIRED in London (mainly for office work) by Contractors for Steam Turbine Power Plants. Applicants should be about 35-40, and must have held a similar position of responsibility and possess excellent all-round practical experience in this class of work.—Address applications (which would be treated in strict confidence), 1708, The Engineer Office. 1708 A

ENGINEER SALESMAN, Young, Unmarried, REQUIRED for Straits Settlements, with works, drawing-office and sales experience. Commencing salary £35 per month. Passage paid; 5 years' agreement.—Write, with full details of experience, stating age, to "Z. P. 366," c/o Deacon's, Fenchurch-avenue, London. 1722 A

EXPERIENCED TESTER REQUIRED for Four-stroke Diesel Engines of moderate power. Permanency and good prospects to suitable man. State previous experience, age, and wages required.—Address, 1739, The Engineer Office. 1739 A

GENERAL MANAGER, Age 35-45, for Important Sheffield Cutlery Manufacturing Company. Salary £1000-£1500 p.a., according to qualifications. State age and previous business career.—Address, P1612, The Engineer Office. P1612 A

HEATING and VENTILATING ENGINEERS REQUIRE a thoroughly experienced and live man as CHIEF of ESTIMATING DEPARTMENT.—Address, 1737, The Engineer Office. 1737 A

LOCAL CORRESPONDENTS.—Opportunity Occurs for live individuals in close touch with building conditions and able to secure earliest information regarding building contracts, in contemplation locally to act as CORRESPONDENT for MANUFACTURERS of PROPRIETARY MATERIAL. Spare-time occupation; no solicitation required; good remuneration. Replies will be treated in strict confidence.—Write, BCM/CLKT, London, W.C. 1. 1736 A

LONDON REPRESENTATIVES. — INTERNATIONAL COMPANY REQUIRE REPRESENTATIVES for London territory on expenses and liberal commission basis. Exclusive territory for fully guaranteed proposition, already taken up by Government Departments and having sale among power stations, municipal engineers and industrial concerns generally. Successful candidates thoroughly supported by technical staff. Give fullest particulars, past experience.—Address, 1685, The Engineer Office. 1685 A

MACHINE TOOL SALESMAN WANTED. Must be thoroughly practical and have good connection amongst large engineering firms. Applicants should state fully their qualifications, experience, and salary required.—Address, 1701, The Engineer Office. 1701 A

MANCHESTER DISTRICT CORRESPONDENT WANTED by Mechanical Engineering Journal. State particulars of experience, terms, &c.—Address, 1721, The Engineer Office. 1721 A

MESSRS. BAGOSINE and CO., 161, Bow-road, E. 3, REQUIRE additional qualified ENGINEER-SALESMEN with a knowledge of Lubricating Oils, particularly in respect of Diesel and similar Engines. P1615 A

REINFORCED CONCRETE.—ASSISTANT RESIDENT ENGINEER REQUIRED IMMEDIATELY to Superintend the Building of Reinforced Concrete Structures. Age about 30. Experience on similar work essential.—Address, stating age, experience, and salary required, 1717, The Engineer Office. 1717 A

REQUIRED for Northern Rhodesia, TECHNICAL OPERATOR, to Take Charge of Furnace Department containing 8 Rotary Gas-fired Kilns. Only those with actual experience of operating gas-fired cement kilns need write, stating qualifications and salary required, together with copies of testimonials.—"G. W.," c/o J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. 1675 A

THE NATIONAL BOILER and GENERAL INSURANCE CO., Ltd., St. Mary's Parsonage, Manchester, REQUIRE additional INSPECTORS. Applicants should be prepared to reside in any part of the country and must be practical engineers with experience in construction, erection and repair of Lifts and Cranes; should have a good theoretical knowledge and be able to make dimensioned sketches; duties to include the examination and tests of all classes of lifts, cranes and other lifting appliances. Salary to commence £260 per annum.—Apply by letter only, marked "Lift and Crane Inspector," giving age, which should be between 25 and 35 years, outline of experience, particulars of certificates of theoretical knowledge and of testimonials, EDWARD G. HILLEE, Chief Engineer and General Manager. 1726 A

WANTED, SENIOR STRUCTURAL DRAUGHTSMAN, with good experience, preferably in London, of Steel-framed Building Designing and Shop Detailing. Must be familiar with working of 1909 Act and used to making his own surveys.

Also First-class JUNIOR, with good experience, preferably in London, of Steel-framed Building Shop Detailing. State salary required.

Apply by letter, "DRAUGHTSMAN," c/o W. Hay Fielding and Co., 43, Old Queen-street, S.W. 1. P1622 A

WANTED in the Midlands, DRAUGHTSMAN, with long experience of the design of Locomotive Steam Cranes. State experience, age, and wages.—Address, 1681, The Engineer Office. 1681 A

CONSTRUCTIONAL DRAUGHTSMAN, First-class man, WANTED, accustomed to seeing jobs through from start to finish. Must have had practical experience and possess sound theoretical knowledge of design.—Apply, stating age, qualifications, salary required, to Constructional Dept., FRODINGHAM IRON and STEEL CO., Ltd., Scunthorpe. 1730 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Shipbuilding Draughtsmen, 99, St. George's-square, London, S.W. 1. 1189 A

DRAUGHTSMAN, Experienced in Marine Diesel Engine design. Salary £5 to £5 10s. per week. State age and experience.—Address, P1620, The Engineer Office. P1620 A

DRAUGHTSMAN (SENIOR) WANTED for Constructional Steel Work. Well accustomed to the full routine of a Constructional Engineer's Estimating and Order Office. Well up in calculations and stresses. Say when disengaged, wages required, age, and fullest particulars.—Address, 1581, The Engineer Office. 1581 A

DRAUGHTSMAN WANTED in London. Must be experienced in Lay-out of Steam Pipe Work for Central Stations. State experience, salary, age.—Box 985, c/o Judd's, 87, Gresham-street, E.C. 1688 A

DRAUGHTSMAN, with All-round Experience of the design and construction of Electrical Generators and Motors, REQUIRED by old-established firm. State full particulars of experience and salary required.—Address, 1698, The Engineer Office. 1698 A

EXPERIENCED MECHANICAL DRAUGHTSMAN, with general engineering experience, REQUIRED for works in London area.—Address, stating age, experience, and salary required, 1735, The Engineer Office. 1735 A

FIRST-CLASS DRAUGHTSMEN REQUIRED; Must be accustomed to the design of all classes of Structural Steel Work.—Address, stating age, experience, and salary expected, 1731, The Engineer Office. 1731 A

GOOD OPENING for MECHANICAL ENGINEER and DRAUGHTSMAN with thorough practical knowledge and experience in the design, construction, and working of Bloudins and Cableways. State experience, salary required.—Address, 1709, The Engineer Office. 1709 A

LEADING DRAUGHTSMAN REQUIRED for Crane Works in the North of England. Permanent position and good salary to one having initiative and first-class experience in the designing and detailing of Electric and Steam Cranes.—Address, giving full particulars of experience, age, and salary required, 1725, The Engineer Office. 1725 A

FOREMAN REQUIRED by Old-established Firm of Engineers for Steam Turbine Department. Only men of proved ability in this class of work need apply. Applications, stating details of practical and technical training, age, and salary required.—Write, Box 1858, Sells, Fleet-street, E.C. 4. 1720 A

FOREMAN REQUIRED for Fitting and Assembling Dept., Light and Medium Machinery. Only first-class men need apply. State full experience, age, salary.—Address, 1573, The Engineer Office. 1573 A

WELDING FOREMAN WANTED for North England; an energetic foreman to Take Charge of the Welding Department of large Lap-welded Tube Plant, water gas process. State experience and wages required.—Address, 1615, The Engineer Office. 1615 A

WORKS FOREMAN REQUIRED. Not Over 35 years of age, for large Structural Engineers in London. Must have held similar position and be used to the control of men. State experience, age, and salary required.—Address, P1607, The Engineer Office. P1607 A

WELDERS. — OXY-ACETYLENE WELDERS WANTED for Tube Works, North England. Only men capable of making and finishing specials need apply. State wages and experience.—Address, 1616, The Engineer Office. 1616 A

SITUATIONS WANTED

A SPANISH and PORTUGUESE-SPEAKING British ENGINEER, with first-class credentials, proved ADMINISTRATIVE ABILITY and energy, with wide technical and commercial experience as Loco. Supt., Chief Engineer, Traffic and Assistant General Manager important railways, recently Director and General Manager of large Engineering, Transportation, Construction and Industrial Company, now closing down, OFFERS SERVICES in SIMILAR CAPACITY, preferably abroad.—R. GODFREY-ASTON (Lt.-Col.), Windyholme, Summerhill, Chislehurst. 1598 B

A.M.I. MECH. E. EXAM. LECTURER, Extensive maintenance experience, steam (coal and oil fuel) and Diesel, DESIRES SITUATION. Excellent references.—Address, P1635, The Engineer Office. P1635 B

COX & DANKS

Ltd.

beg to announce

that they have purchased 200/300 tons of

NEW MILD STEEL CIRCULAR PLATES

varying in thickness from 3/16in. to 5in. and in size from 3ft. 6in. to 5ft. 6in.

THEY ARE SUITABLE FOR MANY ENGINEERING PURPOSES AND FULL PARTICULARS WILL BE SUPPLIED ON APPLICATION.

Head Office: 168, REGENT STREET, LONDON, W.1.

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SITUATIONS WANTED

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

An Aero-Engine Endurance Test.

As we have already recorded, a Bristol "Bloodhound" biplane fitted with a Bristol "Jupiter" air-cooled engine began on January 4th a series of endurance flights between Filton Aerodrome, Bristol, and Croydon. The engine before the test was begun was officially sealed by the Aeronautical Inspection Directorate in such a way that no replacement of any part of the engine, with the exception of the sparking plugs, can be made without breaking the seals. The latest information available shows that the machine has now flown for a total of 180 hours 23 minutes, during which time it has covered a distance of 19,965 miles or the equivalent of seven flights between London and the North Pole. So far not even a minor adjustment or replacement has been made, and the test is still being continued. No other aero engine in any country has, it is claimed, equalled the record so far established. It may be of interest to note that according to the Air Ministry's official hand-book on the Bristol Jupiter engine, the routine rules enjoin a partial overhaul of this engine after 125–150 hours' flying. Such a partial overhaul includes lifting the cylinders, removing the carbon on the cylinder heads and pistons, dismantling and inspecting the valves, and, if necessary, regrinding the valves. After 250–300 hours' flying the rules specify the removal of the engine from the aircraft and a complete stripping, cleaning and inspection. These rules, no doubt, err on the side of caution, and it will be interesting to discover from the test now being made to what extent they might, if necessary, be relaxed.

The Royal Indian Navy.

FURTHER details of the project for creating a Royal Indian Navy, a combatant force which is to supersede the Royal Indian Marine, were given in the House of Commons on Monday. Replying to questions, Earl Winterton stated that the proposed service would be under the control of British officers, but one out of every three vacancies for executive rank would be reserved for an Indian, provided that suitably qualified candidates presented themselves. The Royal Indian Navy is to be maintained entirely at the expense of Indian revenues, subject to any financial arrangements that may be made if at any time its services are placed at the disposal of H.M. Government for non-Indian purposes. Contrary to statements which have lately received publicity, the proposal to establish an Indian Navy enjoys the warm support of a preponderant section of the educated classes in India. Professor Rushbrook Williams states in his comprehensive report on "India in 1924–25" that "the evidence given before the Mercantile Marine Committee plainly shows that Indian political opinion favours the development, hand in hand with an Indian Mercantile Marine, of a Royal Indian Navy, in which the present Royal Indian Marine service would ultimately be incorporated." A definite recommendation was made by this Committee that an Indian Navy should be organised for the defence of India's coasts and shipping, and that a training ship should be stationed at Bombay to train young Indians to become sea officers. The report adds that to judge from the eagerness displayed by the Legislature to put these recommendations into speedy operation, "they command the emphatic approval of important sections of articulate Indian opinion."

West London Electricity.

IT would appear from the parliamentary reports that there is to be further delay in the provision of an adequate supply of electricity in the western suburbs of London. For some years past the power plants in several districts have been so heavily overloaded that it is difficult to arrange for new connections; but it was hoped that a big new station which it was proposed to erect would relieve the situation. This station was to be put up by the London Power Company and to be of not less than 200,000 kilowatts capacity. The site chosen is at Brentford and has admirable facilities for bringing in coal by rail and water, while the Thames would provide an ample supply of cooling water. When, however, a private Bill to authorise the works was put before Parliament on Monday, it was opposed and finally defeated on the score that it would forestall the action of the Joint Electricity Authority. This does not, of course, necessarily mean that the station will not be built. It is rather a question as to whether the plant should be put up by the company or the Authority, and it is probable that a new Bill will be submitted to Parliament next year to decide the point.

The Late Professor Kamerlingh Onnes.

THE distinguished Dutch scientist, Heike Kamerlingh Onnes, died at Leyden on Sunday, the 21st. Professor Onnes was born at Groningen in 1853 and studied at the university of that town. For many years he served as Director of the Physical Laboratory at Leyden University, in which capacity he conducted the experiments by which his name became famous throughout the realm of physics. His work was chiefly concerned with the attainment of low temperatures and the properties of materials manifested at them. He succeeded in liquefying helium at $-268{\cdot}5$ deg. Cent. in 1909 by an adaptation of the Linde process, obtaining in the course of three hours some 60 c.c. of liquid from 200 litres of gas. By the rapid evaporation of liquid helium he actually reached a temperature within one or two degrees of absolute zero. During his experiments with helium he confirmed the belief expressed by certain other scientists that at absolute zero electricity would experience no resistance to its flow in a circuit of pure metal. He found that when a coil of fine lead wire which at normal temperatures had a resistance of over 730 ohms was submerged in a bath of liquid helium an electric current set up in the wire continued to flow for many hours without noticeable diminution. In 1913 Onnes was awarded the Nobel prize for physics, and in 1916 was elected a foreign member of the Royal Society, by which body he was awarded the Rumford Medal.

A New Orient Liner.

WE note with pleasure that the Orient Steam Navigation Company has placed with Vickers Ltd., of Barrow, a repeat order for a passenger liner of the "Orama" class. The Orama and the Otranto were built by Vickers in 1924 and 1925 respectively. The new vessel will, we learn, be of similar dimensions to her three sisters, amongst which is the Oronsay, built by John Brown and Co., Ltd., at Clydebank. The "Orama" liners are 658ft. ships with a gross tonnage of 20,000, and are designed for a service speed of about 18 knots. They have proved to be very popular on the Australian service on account of their well-arranged public rooms and spacious promenade decks. Only two classes of passengers, first and third, are carried. The machinery is of the twin-screw geared turbine type, designed for a total output of 20,000 shaft horse-power, and in the case of the Vickers-built ships it operates on the Parsons impulse and reaction principle. There are three turbines on each of the twin-screw units, so arranged that the high-pressure, intermediate, and low-pressure turbine pinions each mesh with a common gear wheel which is mounted on the propeller shaft. Steam is generated in oil-fired boilers which are designed for a working pressure of 215 lb. per square inch at the turbine stop valves. On her high-power trial the Orama recorded the low figure of 0·785 lb. of oil fuel per shaft horse-power per hour for all purposes, and the operation of the machinery in service has proved, we understand, to be very satisfactory.

The Chamber of Shipping.

AT the annual meeting of the Chamber of Shipping, which was held in London on Friday last, the Rt. Hon. Walter Runciman was elected president. In the course of his address he paid a tribute to the scientific skill and commercial capacity of the shipbuilder and the shipowner, which had rendered carriage by sea the cheapest form of transport in the world. A ton of iron ore, he said, could be carried from Algiers to West Hartlepool, a distance of 1900 miles, for the sum of 6s. 6d., whereas half that sum had to be paid for its further transport of 15 miles from West Hartlepool to Darlington. If it were required to send the ore on to Leeds, a distance of 65 miles, then the railway rate was nearly the same as the sea freight for the 1900 miles. This country, he pointed out, was dependent on its mercantile marine, not only for its prosperity, but also for its very existence. Various resolutions were passed affirming the opinions of the Chamber, on Government intervention, the Trades Facilities Act applied to shipbuilding, taxation, international shipping agreements, docks and lighthouse services. In connection with lighthouses it was stated that the annual cost of this service had risen from about half a million pounds in 1913 to over a million pounds per annum to-day. It was proposed that the lighthouse services should be transferred to the State, and that their administration should be placed in the hands of those who pay the dues and were users of the lights.

The Accumulator Manufacturers' Association.

MANY well-known members of the electrical profession were present at a dinner of the Accumulator Manufacturers' Association held at the Connaught Rooms on Monday, February 22nd, when Mr. B. M. Drake was in the chair. The Association consists of the six large makers of secondary batteries in England, and it was formed to stabilise the business in some of the larger types of accumulators. A trade association is not infrequently regarded as a ring set up to extort the most it can from those with which it deals, but in proposing the toast of "The Association" Mr. Ll. B. Atkinson assured those present that no such object was behind the Accumulator Manufacturers' Association. Its function was, he said, to produce goods of a standard character at a fair price and to deal equitably with the interests of the rest of the electrical trades. It was obvious from some of the speeches, and notably that of Mr. B. M. Drake, that the accumulator manufacturers are not all staunch supporters of the Government's electricity scheme, which, as everyone knows, involves alternating-current distribution, but we do not think that there is the least cause for alarm. The Government's proposals will not render the use of batteries for emergency lighting, &c., in power stations unnecessary. Moreover, it will, in our opinion, be many a long day before all small power plants working in conjunction with storage batteries are abolished. Quite apart from power plant work, however, the accumulator manufacturers are experiencing a greatly increased demand for the smaller batteries used on motor cars and for wireless purposes, whilst the application of batteries to electric vehicles is still a branch of the business that remains to be developed. Some amusing stories were told by Mr. Drake and other speakers, including Sir Hugo Hirst, about the shortcomings of the early accumulators, which, as everyone knows who had anything to do with them, were a source of worry and expense. The modern lead battery, however, is an infinitely better article, and in the absence of altogether new developments in the way of electrical storage it is likely to find an ever-increasing market.

The German Air Service.

THE civil air service in Germany has fallen a victim to its organisation. The two companies which assured the service all over the country, the Junkers Luftverkehr A.G. and the "Aero-Lloyd," created a considerable number of secondary lines to meet the requirements of municipalities which regarded the aeroplane as an established means of transport and offered subsidies that were eagerly sought after by the organisers. Every opportunity of opening new lines for the sake of putting new machines into service was seized. Being largely financed by the Junkers Aeroplane Works, the companies were bound by contract to employ Junkers machines up to 50 per cent. of their total equipment, and arrangements were being made even to ensure a complete unity of type with the idea of cutting down the production and maintenance costs to the lowest possible level. The result of this system was that while the companies were losing heavily, despite the subsidies, the organisation had the effect of limiting the types of machines employed to two, so that while in other countries the technical side of aviation was undergoing a steady development, in Germany it was at a standstill. In these circumstances the State suspended the subsidies, representing two-thirds of the cost of running the services, and in view of the failure of private initiative it even proposed to take over civil aviation as a State monopoly. The two companies therefore found it necessary to amalgamate independently of manufacturing interests and to acquire the best machines in open competition, so that the entire service would be in the hands of one company and all the aircraft builders would have a chance of getting their machines employed. On account of the withdrawal of the subsidies civil aviation in Germany is, for the moment, entirely suspended, but it is likely to be resumed by the new organisation in a very short time.

An Egyptian Irrigation Scheme.

IT is announced that a beginning with a large irrigation scheme for Egypt is about to be made by constructing a new dam on the White Nile at Gebel Aulia, near Khartoum, with a barrage at Nag Hamadi, in Upper Egypt. The work, it is said, will occupy about three years, and will, it is estimated, cost about £6,000,000, whilst a similar sum, it is expected, will be expended on subsidiary developments in connection with the main works. The hope is expressed that both contracts may be secured by British firms. The construction of this Dam, which was recently approved by the Egyptian Government, will bring to a satisfactory conclusion the many difficulties which have intervened in the negotiations since the preliminary work was done in 1914 in conjunction with the Sennar Dam. We are informed that plans for the new work are to be prepared by Messrs. Coode, Fitzmaurice, Wilson and Mitchell, of Westminster, who were the consulting engineers for the Sennar Dam, and have been retained by the Egyptian Government for the new work. Mr. A. G. Vaughan-Lee, M. Inst. C.E., a member of the firm of consulting engineers, is at present in Egypt, and is shortly leaving for England in order to assist in the work of inviting tenders for the undertaking. The new dam which is contemplated will form a sister reservoir to the Sennar, which supplies water from the Blue Nile to the Gezira irrigation scheme, and will constitute another important link in the vast system of irrigation for Egypt and the Sudan. It may be of interest to recall in this connection that in our issue of September 26th, 1924, an account of the work upon the Sennar Dam in the working season 1923–1924 was given, and in July 3rd of last year a description of the later work was published in THE ENGINEER. On August 28th, 1925, we published an account of the Gezira irrigation system. The official opening of the Sennar Reservoir did not take place until January 21st of this year.

Linoleum Machinery.

No. VI.*

PAINT MAKING.

THE preparation of the paint used in a linoleum factory making printed material is quite an important matter, as large quantities have to be produced, and the cost of production must naturally be reduced to a minimum. The whole process is, of course, only a matter of properly mixing the several ingredients together and producing a material of the requisite consistency without any contained foreign matter, and a number of machines are employed for this purpose. There are several entirely distinct classes of apparatus in general vogue, but the sequence in which they are employed varies in different factories. There is nevertheless a certain degree of distinction between the several machines in so far that some are intended for the earlier processes and others for the more refined preparation of the paint. It may thus be best to give an outline of the machines individually, and then to explain their employment in sequence.

The ingredients comprise a mixture of oil, whiting, lithopone, and the necessary colouring matter, and, with the exception of the pigment, the body is always roughly mixed together either in a pug mill or by an edge runner.

A pug mill, by Bertram's, of Edinburgh, is illustrated in Fig. 36, and needs little comment, as its construction is fairly obvious in the engraving, while another form, by Sidney Smith and Blyth, of 35, Garratt-lane, Wandsworth, can be seen in the upper part of Fig. 37. In this case a long cylindrical drum is supported by two tall A frames, and is provided with a partition at the middle of its length. Inside this drum there is a pair of horizontal spindles, one for each partition, which are driven by the gearing shown, and are provided with stirring arms.

The reason for dividing the cylinder into two by this partition is that the paint must be mixed in batches, for convenience in proportioning the various ingredients, and by providing two chambers the subsequent processes can be run continuously, one section being kept actively at work while the other is discharging its contents to the next machine. The drum is fitted with two doors for the discharge of the mixture. A single compartment mixer, by Bertram's, of Edinburgh, is shown in Fig. 39.

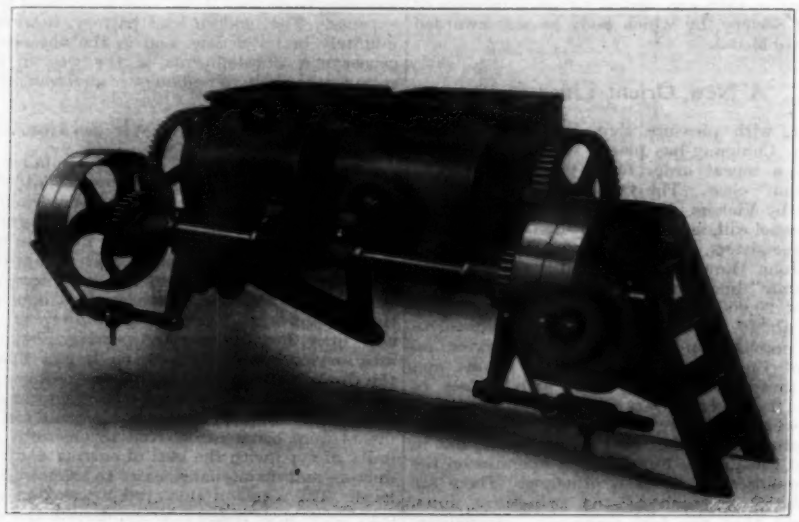


FIG. 36—WALL PUG MILL—BERTRAMS

An alternative machine for rough mixing, which is sometimes used to precede the pug mill, or "cooler," as it is then called, is shown in Fig. 40. The actual machine illustrated is by Smith and Blyth, and, as will be seen, is very similar in construction to a mortar mill, except that the roll is driven, instead of the pan being rotated, and it has only one roll, which is of cast iron. The roll is mounted on a trunnion fixed at the end of an arm pivoted to a bracket at the top of the driving spindle, so that the roll can ride easily over any hard lump in the pan. In order to ensure that the roll runs round its track properly it is provided with teeth which mesh in a fixed crown wheel that gives it a positive drive. A plough is arranged in front to keep the paint under the roll, and a door is provided for letting the charge out.

The next operation is to grind the mixture to a more uniform consistency, and the usual machine for this purpose is a two-roll mill, such as that shown in Figs. 37 and 38, which comprises two chilled cast iron rolls ground with a mirror-like surface and mounted in a framing so that they can be adjusted with a very fine clearance. The two rolls are driven at different speeds, to produce a tearing action on the material, and in the case under review silent tooth chain gearing is used in order to accommodate the adjustment of the rolls. The rolls are hollow and are provided with water circulation, as the grinding action produces considerable heat, which would be detrimental to the paint if it were not kept under control.

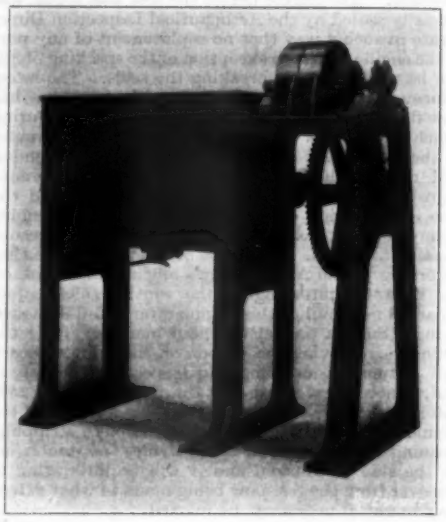


FIG. 39 PAINT MIXER BERTRAMS

The paste is subsequently transferred to a set of "whirlpool" mixers, which are simply vertical spindles provided with arms that revolve inside large cylindrical "tubs." Covers are provided to prevent splashing, and the stirrers are so connected with the drive above that they can be readily disconnected and the tub taken away when the operation is completed.

The last operation is that of fine grinding, and during it great care has to be taken, as, if the machines are run too fast, there is a liability for the paint to be thickened. For this purpose Mr. Smith has invented

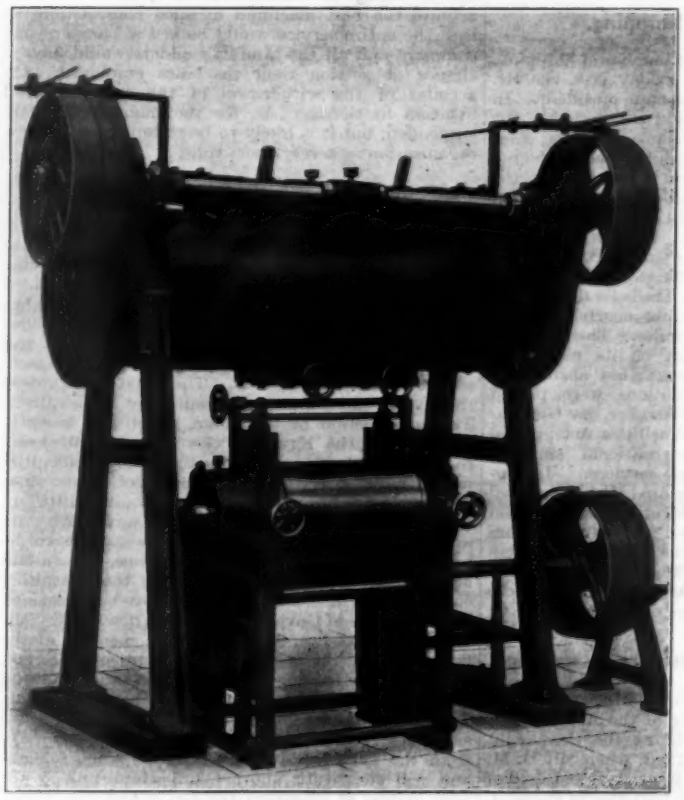


FIG. 37 TWIN MIXER AND TWO-ROLL MILL SMITH AND BLYTH

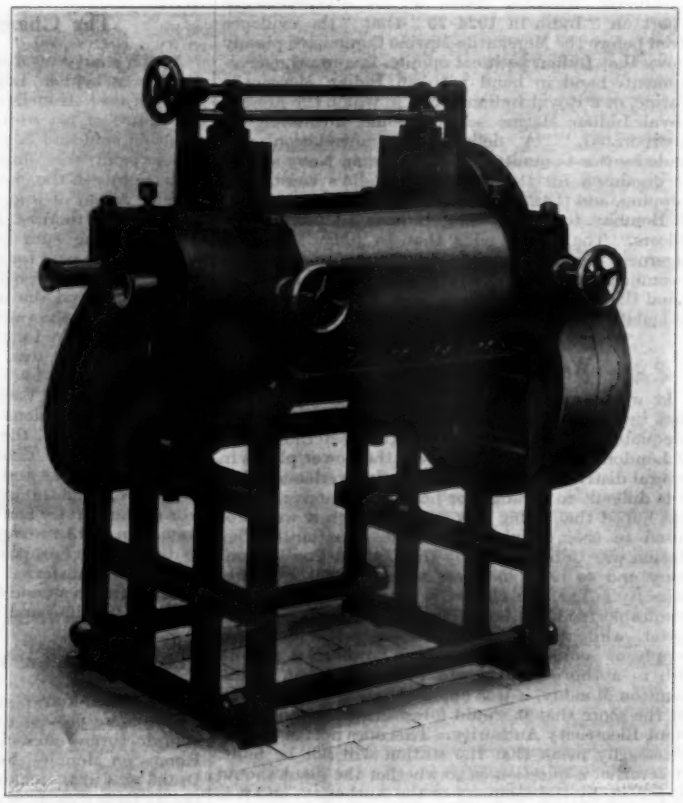


FIG. 38 TWO-ROLL PAINT MIXER—SMITH AND BLYTH

* No. V. appeared February 19th.

a rather remarkable form of mill, which is illustrated by Fig. 41. In it there is only a single roll, and the paint is ground between this roll and a fixed longitudinal bar. The roll is, of course, very hard and is

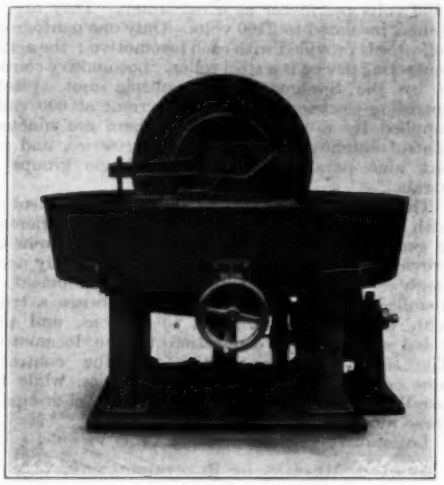


FIG. 40—EDGE-RUNNER MILL—SMITH AND BLYTH

ground to a smooth surface. In the case illustrated it is 15in. in diameter by 30in. long, and is driven through gearing at a speed of about 120 revolutions per minute. At one end of its spindle there is keyed a scroll-shaped cam, which engages with a fixed roller and gives the main roll a slight endways movement, that is accommodated in the length of the teeth of the driving gears, and ensures that the roll and bar wear evenly. Across the front of the machine there is fixed a stiff girder in which the grinding bar is fixed. The bar is of cast iron and about ⅝in. wide at the working edge. This edge is ground hollow to fit the curvature of the roll. The bar is held in place by the thumb screws and springs, seen in the illustration, and is adjusted for clearance from the roll, according to the quality of paint required, by the screws with knurled heads. The hopper for holding the stock of paint is made a very nice fit on the roll, and against the bar, and can be adjusted in place by means of the micrometer screws that can be seen over the tops of the end frames.

It might be thought, in view of the narrow face presented to the roll by the bar, that it would wear away rapidly, and also that the paint would quickly pass under it without much refining, but, as a matter of fact, the reverse is the case. The bars have a very long life, and not only is the paint ground very fine, but all impurities, such as fibres and grit, are also prevented from passing the bar and are retained in the hopper. The hopper is, of course, cleaned out after the day's run, and the care bestowed on this job affects the life of the machine as much as anything else. If, after cleaning out, the bar is carelessly put down again with a piece of grit beneath it, the bar and roll will be quickly scored. The output of these mills naturally varies with the class of paint being made, but ranges in the case of the size illustrated from 120 to 200 gallons a day of eight hours.

Another process of paint making, advocated by some linoleum manufacturers, is to mix the oil, lithopone, whiting, &c., roughly together in a large pug mill and pass it on to a mill after the fashion of that shown in Fig. 40.

The mixture is dropped from this pan into another horizontal pug mill, and is worked from it through a shoot into a double set of granite roll mills. This mill has usually two sets of rollers, all the rollers being driven at different speeds through sets of gearing. In most cases the centre roll is reciprocated back and forward about 1in. or 1¼in. to keep the surface of the rolls in good order. Such a mill, by Bertram's, is illustrated in Fig. 42. The paint is then passed through the mills into pans where the stock colour—which is usually white—is kept ready for blending or colouring up. This blending is done by putting the colour, such as we have described, into a large mixer sometimes horizontal and sometimes vertical, with revolving arms inside. The colour for making the different shades is also put in, and the whole is thoroughly mixed. After being mixed and brought to the proper consistency with the addition of oil, dryers, &c., the paint is transferred to a large tank or receiver which has a small strainer or sieve on top to strain the colour and keep back all grit and foreign matter. It is kept there ready for running into the trolleys or colour barrows which are used alongside the various machines for holding the stock of colour to keep the machine running.

Some firms use Pfleiderer mixers for mixing up the stock colour where the oil, whiting, lithopone, &c., are incorporated with each other. This stock is then passed through granite rolls, as already described, and the colour is put once through the rolls and sometimes fairly often, according to the quality of the colour required.

The line drawing—Fig. 43—shows the general arrangement of a paint factory set out by Sidney Smith and Blyth for a special purpose, but it would require little alteration to be applicable to the requirements of the linoleum trade, while it has the merit of reducing manual labour to a minimum.

As will be seen, the dry materials, whether colour or filler, are elevated to a bin, from which they gravitate into a Raymond crusher, and, after passing through a separator, to ensure that nothing over a size which will pass a sieve of 320 meshes to the inch is carried forward. The material is passed through a cyclone, and is delivered to a storage loft. From this loft the various ingredients, weighed out in the proper proportions, are sent down a shoot to a mixer and mill such as that shown in Fig. 37. The paste is then discharged into a pair of whirlpool mixers, which are peculiar in so far that the tubs are mounted on hydraulic rams, so that they may be pushed up to meet the mixing arms. When the mixing is completed the tubs are lowered to floor level again, and are pushed over on castors to a set of elevators, that raise them to such a height that the liquid will gravitate to the single-roll mills—see Fig. 41. The paint coming from these machines is ready for use, and can be put up in tins or taken away in bulk as may be required. The capacity of the factory illustrated is 5 tons of paint for an eight-hour day.

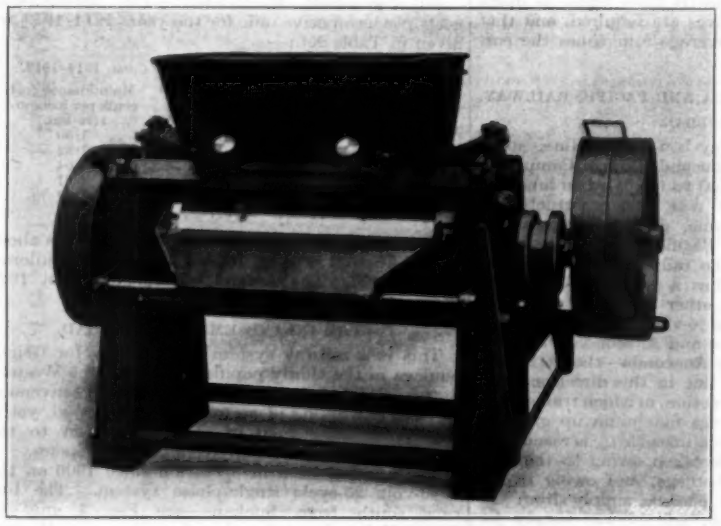


FIG. 41—SINGLE-ROLL PAINT MILL—SMITH AND BLYTH

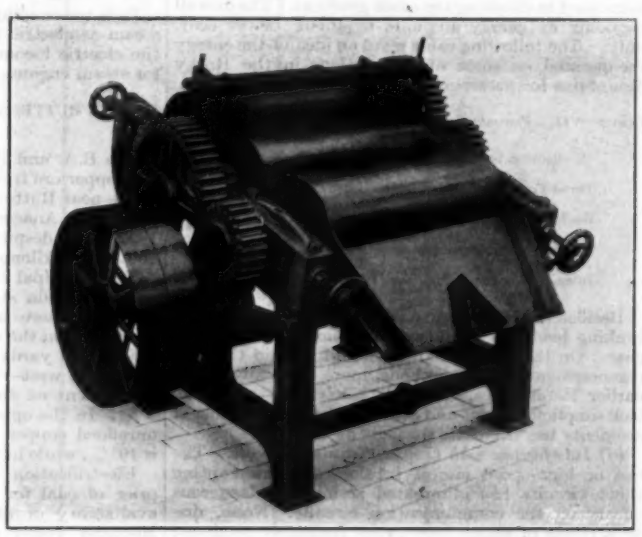


FIG. 42—PAINT MILL WITH THREE GRANITE ROLLS—BERTRAMS

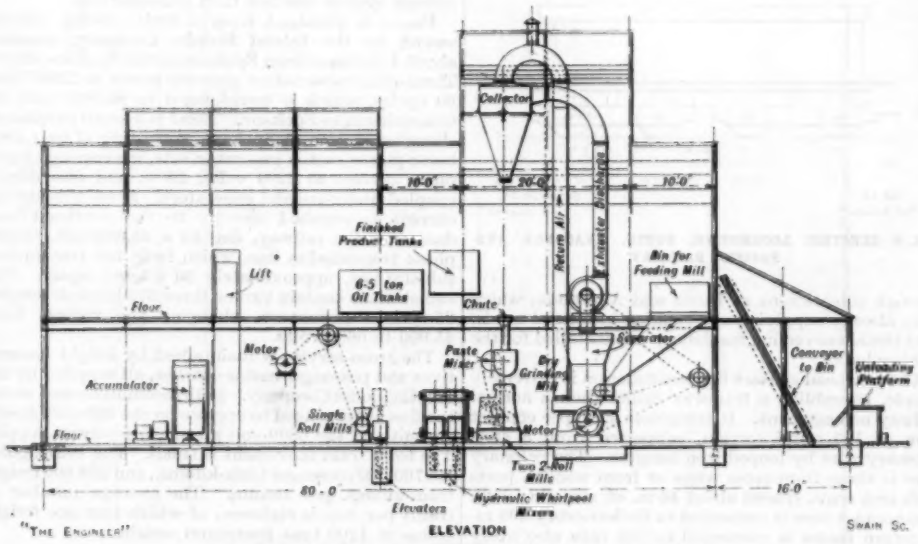


FIG. 43—GENERAL ARRANGEMENT OF A PAINT FACTORY

Main Line Railway Electrification.

By Sir PHILIP DAWSON, M. Inst. C.E., &c., Consulting Engineer, and

S. PARKER SMITH, D.Sc., M.I.E.E., Professor of Electrical Engineering, Royal Technical College, Glasgow.

No. XII.—U.S.A.: NORTH-WESTERN STATES.*

A.—THE CHICAGO, MILWAUKEE AND ST. PAUL RAILWAY (*continued*).

5. RESULTS OF ELECTRIFICATION.

(*a*) *General.*—The electrification of the C.M.S.P. Railway has shown some notable results. First, there has been a considerable reduction in the number of locomotives required for the service, more than double the number of steam locomotives being required for the same service as is now being given electrically. This is due to the increased daily mileage possible per locomotive, the increased speed on

* Nos. I., II. and III. (Switzerland) appeared June 6th, 13th and 20th, 1924; Nos. IV. and IVA. (Scandinavia) appeared January 23rd and February 6th, 1925; Nos. V. and VI. (Germany) appeared June 5th and 12th, 1925; Nos. VII. and VIII. (Austria) appeared August 21st and 28th, 1925; Nos. IX. and X. (France) appeared October 2nd and 23rd, 1925; and No. XI. (U.S.A., North-Western States) appeared February 12th, 1926.

gradients, and the increased load per locomotive. All this has further tended to a reduction in staff.

Besides these benefits, notable progress has been made with regard to the regularity of the service. Even the most vigorous winter has not caused serious delays, such as were common with steam haulage.

(*b*) *Energy Consumption.*—Energy consumption per ton-kilom. is very small, the output of the Montana Power Company for traction purposes to the C.M.S.P. Railway in 1917–1918, for example, being 30 watt-hours per trailing ton-kilometre. This energy includes lighting, signalling, &c., and represents the net consumption measured at the H.T. feeding points of the M.P. Company.

The following figures are taken from those tabulated by Mr. Beeuwkes for the year 1919 :—

TABLE VI.—*Energy Consumption in* 1919, *C.M. and St. P. Rly.*

Service.	Energy consumption in W-h. per ton-km.			
	Including locomotive weight.		Excluding locomotive weight.	
	At h.t. feeding points.	On the locomotives.	At h.t. feeding points.	On the locomotives.
Passenger	43·0	29·2	30·1	20·6
Freight	30·3	20·6	26·4	17·8
Total (mean) ..	31·8	21·6	26·9	18·2

(*c*) *Regenerative Braking.*—The small energy consumption is due in part to the regenerative braking. For example, in a test conducted for the period January 21st to 27th, 1917, the energy returned to the line by passenger trains descending the gradient of 20 $^{o}/_{oo}$ from Donald to Piedmont attained the remarkable figure of 42·8 per cent. of the energy consumed in climbing the same gradient. The overall economy in energy amounts to about 14 per cent. only. The following table gives an idea of the energy recuperated on some of the sections in the Rocky Mountains for passenger trains :

TABLE VII.—*Percentage Energy Recuperation : Harlowton–Deer Lodge.*

Section between.	Direction.	Recuperation, per cent.
Three Forks and Deer Lodge	East	25
	West	7
Harlowton and Three Forks	East	11
	West	9
Harlowton and Deer Lodge	East	19
	West	8
In each direction	—	14

Besides reducing energy consumption, regenerative braking leads to considerable economy in air-brake gear. On the other hand, it should be said that the regenerative braking methods, more especially in the earlier locomotives, although electrically complete, lack simplicity, range and general safety. A number of accidents has occurred through its use.

(*d*) *Interference with Communication Circuits.*—The use of high-speed circuit breakers for interrupting short circuits has eliminated serious or dangerous effects on the communication circuits. Noise, due to a ripple of about 1500 cycles frequency produced by tooth effects in the sub-station motor generator sets, was originally experienced, but it has been very greatly reduced by suitable relative positioning of the armature slots on the two series-connected generators, and more particularly by the use of resonant shunts. The results show that there will be no appreciable trouble between properly equipped direct-current railway systems and suitably constructed communication circuits, if proper precautions be taken and care given to the design of the traction machinery.

(*e*) *Costs and Savings.*—In Table VIII. is given a summary of the amounts of gross and net savings from electrification, as compared with the estimated cost of steam operation up to the end of 1924. The Harlowton–Avery section was opened to electric haulage between April and November, 1916, whilst electric operation began on the Coast Division (Othello–Tacoma) in March, 1920.

TABLE VIII.—*Gross and Net Savings from Electrification up to the end of* 1924.

	Harlowton–Avery.	Othello–Tacoma.
Years of operation	8·5 ..	4·7
Net savings, dollars	11,868,247 ..	531,760
Interest and depreciation, dollars	4,352,000 ..	2,480,000
Gross savings, dollars ..	16,220,247 ..	3,011,760
Gross savings, both divisions, dollars	19,232,007	

Thus the C.M.S.P. Railway Company estimates that it has saved a gross sum of over 19 million dollars over what would have been the cost of steam operation with existing equipment during the same period. The total saving represents 83·6 per cent. of the gross first cost of 22,990,254 dollars for the complete electrification of 1045 kiloms. of route. It may be mentioned that the gross ton-kilometres operated over the electric zone has been considerably less than that anticipated, being, on the Harlowton–Avery division, about 4200 million ton-kilometres in 1919, falling to 3700 million in 1920, 2700 million in 1921, and an increase to about 3300 million ton-kilometres in 1923.

The operating expenses for electric working compared with estimated steam costs for the year 1923 are shown in Table IX.

TABLE IX.—*Comparative Operating Expenses for* 1923.
Gross ton-km. = 4400 million.
Route-km. = 1046.

	Steam, dollars.	Electric, dollars.	Per 1000 gross ton-km. Steam, cents.	Per 1000 gross ton-km. Electric, cents.
Maintenance—				
Transmission and trolley	—	102,706	—	2·3
Sub-stations	—	30,631	—	0·7
Locomotives	1,335,009	480,236	30·0	10·8
Other items	538,050	398,185	12·1	9·0
Transportation—				
Fuel or power ..	1,790,000	1,228,004	40·4	27·7
Enginemen ..	836,000	463,945	18·8	10·5
Trainmen	788,000	483,975	17·7	10·9
Engine-house expenses	285,000	118,895	6·4	2·6
Other items	424,624	321,363	9·5	7·8
	5,996,673	3,627,940	134·9	82·3
Electric saving		2,368,733		52·6

Gross return on gross capital expenditure—

$$= \frac{2,368,733}{22,990,254} = 10{\cdot}3 \text{ per cent.}$$

(*f*) *Locomotive Maintenance.*—Table X. compares the first cost and maintenance cost for the same service of steam and electric locomotives for the whole electrification :—

TABLE X.—*First and Maintenance Costs of Steam and Electric Locomotives.*

	Steam.	Electric.
Tota number of locomotives	167 ..	59
First cost, dollars	5,615,505 ..	8,069,574
Annual maintenance, dollars	1,335,009 ..	480,236
Percentage of first cost ..	25·3 ..	5·95

It is noteworthy that nearly three times as many steam as electric locomotives are required, and that the electric locomotives average four times the cost for steam engines.

B.—THE BUTTE, ANACONDA AND PACIFIC RAILWAY.

1. GENERAL.

The B.A. and P. Railway is a mineral line, carrying copper ore from the Anaconda Copper Company's mines near Butte (Montana) to the Washoe Smelting Works at Anaconda. It was first constructed in 1892, and, despite its name, does not run within about 1000 kiloms. of the Pacific Ocean—Fig. 1 *ante*.

The principal line of the railway, between Butte and Anaconda stations, has a length of nearly 42 kiloms. There are two other branches electrified running from the main line to various smelting installations and yards at Butte and Anaconda. Full ore trains run west—Butte to Anaconda—the maximum up gradient on the main line in this direction being $3^{o}/_{oo}$. In the opposite direction, in which trains carry unrefined copper ingots, the maximum up gradient is $10^{o}/_{oo}$, while in the branch lines $25^{o}/_{oo}$ is reached.

Electrification was undertaken owing to the high price of coal for steam haulage, and owing to the availability of abundant electric supply from the Montana Power Company, and it was simply for economy that the line was equipped electrically by the G.E. Company in 1912–13. The system chosen was high-tension direct current at 2400 volts, the highest direct-current voltage employed at the time.

The line is fed by the Montana Power Company

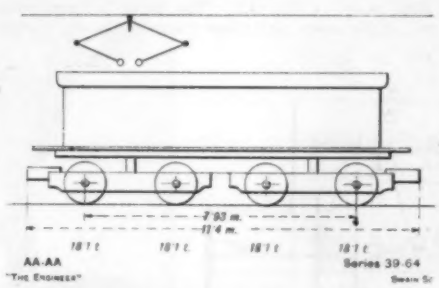


FIG. 5—ELECTRIC LOCOMOTIVE, BUTTE, ANACONDA AND PACIFIC RAILWAY

through sub-stations at Butte and Anaconda, which were already supplying surrounding industrial needs. Additional converting machinery was installed for the railway load.

The overhead contact line construction is extremely simple, resembling a tramway rather than a normal railway arrangement. It comprises a copper contact wire of 105 mm.^{2} section, supported from a steel catenary wire by looped iron hangers. The catenary wire is slung from cross wires or from wooden posts with iron arms, spaced about 46 m. on straight track. The contact wire is connected to feeders every 300 m. A return feeder is connected to the rails also every 300 m. on the main line.

Locomotives.—The rolling stock comprises two passenger locomotives, twenty-six freight locomotives and three auxiliary tractors, all supplied by the G.E. Company—see Fig. 5.

The A A — A A freight locomotives have been constructed for working generally with double heading, but can also be used alone for shunting, &c. The motors—320 horse-power on 1-hour rating—are nose-suspended, and drive on each side by plain gears, without any cushioning device. The two motors of each bogie are connected permanently in series, giving 1200 volts per motor as a maximum. They are, of course, insulated to 2400 volts. Only one pantograph collector is provided with each locomotive ; the actual contacting device is a steel roller. Locomotive control is by the Sprague-G.E.C. multiple unit system, operating electrically by direct current at 600 volts, supplied by a "dynamotor." There are nineteen control notches, the first ten being series, and the last nine parallel—*i.e.*, the two bogie groups in parallel.

The passenger locomotives are practically identical with the freight locomotives, except for the difference in gear ratio, and the fact that two pantographs are provided, as the passenger locomotives only work singly. No regenerative braking equipment is installed. The auxiliary tractor comprises a truck with two motors, weighted to 36 tons, and provided with suitable connection to the locomotive. The series running positions of the controller now correspond to six motors in series, while the parallel notches correspond to two parallel groups of three motors in series.

Locomotive data are given in Table V. *ante*.

2. RESULTS OF ELECTRIFICATION.

(*a*) *General.*—Increase of train speeds on up gradients and increase of train weight has given a better utilisation of wagon stock than was possible with steam. The train weights have been increased on the average by 35 per cent., and the number of trains by 26 per cent., compared with steam haulage. In 1913–14 the annual saving due to the electrification amounted to 20 per cent. of the capital electrification cost, while some steam locomotives were yet running.

(*b*) *Locomotive Maintenance.*—The maintenance costs per locomotive mile for the years 1914–1919 are given in Table XI.:—

TABLE XI.—*Locomotive Maintenance Costs,* 1914–1919.

Year.	Maintenance cost, cents per locomotive-km.
1914	3·30
1915	3·82
1916	3·04
1917	3·91
1918	3·97
1919	4·11

The mean annual travel of a locomotive was about 50,000 kiloms. in 1914–15 and about 68,000 kiloms. in 1916–17. The freight ton-kilometres in 1920 aggregated about 300 million.

C.—THE INLAND EMPIRE RAILROAD.

This is a railway system used mainly for freight haulage in the thinly populated part of the Western States. While it is not an example of the conversion to electric working of an existing steam road, yet it shows the adaptation of electric traction to the character of service usually conducted by steam.

The line has been in operation since 1906 on the 6600-volt 25-cycle single-phase system. The line runs south from Spokane—see Fig. 1 *ante*—to Spring Valley Junction, where branches go to Moscow (Idaho) and Colfax (Washington). In the streets of Spokane for 4 kiloms. the system is 600 volts direct current, overhead conductor.

The choice of the single-phase system was probably decided upon from consideration of the length of the line and the nature of its traffic. Such considerations would naturally lead to the decision for single-phase operation at the time of building, as the H.T. direct-current system was not then a competitor.

Power is obtained from a hydro-electric station owned by the Inland Empire Company, situated about 15 kiloms. from Spokane on the Spokane River. Three-phase alternators generate power at 2200 volts, 60 cycles, which is transformed to 60,000 volts for transmission to Spokane. There is a small frequency-changing station at Spokane, consisting of four 1000 horse-power motor generator sets, generating single-phase current at 2200 volts, 25 ~, and also direct-coupled direct-current generators. From this station current is supplied directly to the overhead conductor of the railway, and to a 45,000-volt, single-phase transmission line, which feeds ten transformer sub-stations, approximately 20 kiloms. apart. The sub-stations contain two or three 375 kilovolt-ampère 25-cycle transformers, changing the voltage from 45,000 to 6600 volts.

The train service is maintained by freight locomotives and passenger motor coaches, all supplied by the Westinghouse Company. Both locomotives and motor coaches are arranged to operate on the 600-volt direct-current and the 6600-volt alternating-current supply. The total train movement is small. The 1921 figures are 700,000 passenger train-kiloms., and 280,000 freight train-kiloms. per annum. The average number of trains per day is eighteen, of which four are freight trains of 1200 tons maximum weight.

D.—GREAT NORTHERN RAILWAY (CASCADE TUNNEL ELECTRIFICATION).

1. GENERAL.

The Cascade electrification in the Cascade Mountains, Washington, is an example of mountain-gradient tunnel operation for freight and passenger trains,

MAIN LINE ELECTRIFICATION IN THE UNITED STATES

TABLE XII.—U.S.A. (NORTH-WESTERN STATES) RAILWAY ELECTRIFICATION.

Railway.	Division.		GENERAL. Date opened for elect.	Route length.	No. of tracks.	Gauge.	Max. gradient.	Rail weight.	Max. allowable speed.	CONTACT LINE. Current voltage and frequency.	Contact line.	Return.	Contact line suspension.	Description and spacing of supports.	Insulation.	POWER SUPPLY. No. of feeding pts.	Feeding points.	Mean route length per feeding point.	Feeding lines.	Transmission lines.	Power stations.
				km.		m.	‰	kg./m.	km./hr.												
Chicago, Milwaukee & St. Paul Railway.	Harlowton - Deer Lodge-Avery ..	1	1915–1916	707	1	1·435	20	44		Direct current. 3000 volts	Two parallel copper contact wires, each 105 mm².	Rails and return feeder, 105 mm²., carried on overhead line supports.	Simple catenary. Each contact wire supported by looped droppers at 4·5 m. intervals.	Wood poles, 12 m. long, spaced 45 m. on straight track.	Single.	14	*Motor generator sub-stations:* Sets. K.W. total. Two Dot .. 2 .. 4000; Loweth .. .. 2 .. 4000; Josephine .. 2 .. 4000; Eustis .. .. 2 .. 4000; Piedmont .. 3 .. 4500; Janney .. .. 3 .. 4500; Morel .. .. 2 .. 4000; Gold Creek .. 2 .. 4000; Ravenna .. 2 .. 4000; Primrose .. 2 .. 4000; Tarkio .. .. 2 .. 4000; Drexel .. .. 2 .. 4000; E. Portal .. 3 .. 6000; Avery .. .. 3 .. 4500	50	Feeders at 3000 v. carried on overhead line supports. Single wire, 250 mm²., throughout, doubled on heavy gradients	100 kV lines of the Montana Power Co. feed directly to Two Dot, Josephine, Piedmont, Morel, Gold Creek, and E. Portal. All sub-stations further interconnected by 100 kV line alongside track	*Montana Power Co.'s hydro-electric stations:* kW. Thomson Falls .. 30,000; Holter .. .. 40,000; Great Falls .. 60,000; Rainbow Falls .. 35,000; Madison 1 and 2 .. 12,000; Big Hole 3,000
	Avery-Othello	2	—	342	1	1·435	10	44													
	Othello-Tacoma and Renton-Seattle	3	1919–1920	339	1 (Seattle-Black R., 2)	1·435	22	44			Steel catenary cable	Bonding by 125 mm². copper. Double bonds on gradients heavier than 10‰.	Contact wires 7·3 m. above rail level.	Metal T-section bracket arms.		8	*Motor generator sub-stations:* Sets. K.W. total. Taunton .. 2 .. 4000; Doris .. .. 2 .. 4000; Kittitas .. .. 2 .. 4000; Cle Elum .. 1 .. 2000; Hyak .. .. 2 .. 4000; Cedar Falls .. 2 .. 4000; Renton .. .. 1 .. 2000; Tacoma .. 2 .. 4000	42	3000 v. feeders on overhead line supports: Feeder. mm². Othello-Beverley .. 1 .. 250; Beverley-Doris .. 2 .. 250; Doris-Kittitas .. 2 .. 350; Kittitas-Hyak .. 1 .. 250; Hyak-Cedar F. .. 2 .. 350; Cedar F.-Renton .. 1 .. 250; Renton-Black River 1 .. 250; Black River-Tacoma 1 .. 105	Long Lake P.S. connected to Taunton sub-station by 100 kV 3-phase line. Snoqualmie Falls P.S. connected to Cedar Falls and Renton by 100 kV lines. Renton-Tacoma and Taunton-Cedar Falls connected by 100 kV line along railway	East of Cascade range normally fed from Long Lake P.S. (Intermountain P. Co.). Three 4000 v., 60 per., 3-ph. generators, 19,500 kVA. Emergency connection to Post Falls and Little Falls P.S. West section fed from Snoqualmie Falls P.S. Emergency connection to White River and Electron P.S. kW. Snoqualmie Falls 18,000; White River .. 52,000; Electron 14,000
Butte, Anaconda & Pacific Rly.	Butte-Anaconda and branches	4	1913	42 (180 track-km.)		1·435	19 (45 in yds.)		80 (pass) 56 (fr't.)	Direct current. 2400 volts.	Copper contact wire, 105 mm². Steel catenary cable.	Rails connected to return feeder every 300 m.	Simple catenary. 6·7 m. above track.	Cross-wires or bracket arms on wood poles. Spacing 45 m. on straight track.	Single.	2	*Motor generator sub-stations:* 1000 kW sets. Anaconda, 3 sets Butte, 2 sets Total, 5000 kW	21	Two copper feeders, each 250 mm²., between Butte and Anaconda sub-stations	Montana Power Co.	Montana Power Co.'s stations *via* Butte sub-station
Inland Empire R.R.	Spokane-Moscow and Spring Valley-Carfax	5	1906	208	1	1·435				Single-phase. 6000 volts. 25 per.	Copper contact wire. 85 mm². Steel catenary cable.	Rails	Simple catenary 6·7 m. above track.	Wood poles with iron bracket arms.	Single.	11	10 *transformer sub-stations:* Having 2 or 3 units of 375 kVA each. Total 15,250 kVA. 1 *frequency changer station:* 3-ph., 60 per., to 1-ph., 25 per., 2200 v., 4000 kW.	19	Feeders from frequency changer station to transformer sub-stations at 45,000 v., 25 per., single-phase	From Spokane River P.S. to frequency changer station at 60 kV, 60 per., 3-phase	Spokane River P.S. (hydro-electric). Four 3000 kW, 2200 v., 3-ph., 60-per. generators
Gt. Northern R.R.	Cascade Tunnel Skykomish extension	6	1909 —	46	1	1·435	23·5		56	Single-phase. 11,000 volts. 25 per.	Bronze contact wire, 105 mm². Copper catenary cable, 18 mm. dia.	Rails.	Simple inclined catenary.	Wood poles with iron bracket arms. Spacing 45 m. on straight track.	Single.	3	*Static transformer sub-stations:* Tye Alpine Skykomish	15	Special feeder system to supplement contact line	From Tum Water P.S. to transformer sub-stations	Tum Water P.S. (hydro-electric).

having for its purpose the elimination of smoke from steam locomotives in a long tunnel. The length of the line is about 6·5 kiloms., of which 4·2 kiloms. is in a single-track tunnel, having a continuous grade of 17°/₀₀, with 22°/₀₀ gradients in the tunnel approach. As the tunnel is not a division terminal, trains including steam locomotives, are hauled up the gradient by electric locomotives.

The electric system is at present the straight three-phase at 6000 volts between phases, using two overhead trolley wires as required by this system, the only example of its kind in America.

Power is generated in a hydro-electric plant at Leavenworth (Tum Water), situated about 50 kiloms. from the tunnel, transmission being by two three-phase lines at 33,000 volts. At a sub-station of 2550 kilowatts capacity the transmitted energy is transformed down and fed to the contact lines at 6600 volts.

The locomotives collect the current by wheel trolleys—*i.e.*, tramway type—and a transformer supplies the motors at 500 volts three-phase. The drive is by nose-suspended motors through gearing. For data see Table V. *ante*.

The chief tonnage to be hauled on this line is on freight trains. The freight ton-kilometres in 1921 were 12·3 million. This was handled by four electric locomotives.

2. Further Developments.

Owing partly to the objection to the overhead line complication, unavoidable with three-phase working, the railway company has not extended this system beyond the tunnel. Work is, however, in hand for the conversion of the tunnel to single-phase at 12,000 volts and the extension of the electrification to Skykomish at the foot of the western slope of the Cascade Mountains, involving an additional route-length of about 39 kiloms. Power will be supplied from Tum Water. The locomotives will consist of two units, one completely equipped with a transformer and single-phase motor-generator, furnishing direct-current energy to series traction motors. Speed control and starting will be effected by field control of the main generator, giving a maximum of 600 volts on the motors. Recuperation of energy will be possible without any complication over a wide range of speed. The locomotive unit embodying the motor generator and transformer will also feed a coupled unit, with the same axle arrangement—1 A A A A 1—ballasted up to the same weight.

In order to maintain the present three-phase locomotives in service after the conversion of the tunnel line to single-phase, they will be operated in conjunction with a tender, in which will be mounted a transformer and phase converter to supply three-phase energy.

The scheme detailed above is announced by the railway company as an initial undertaking to prepare the way and gain experience for an extensive programme of electrification on its western lines. It is expected ultimately to include over 1500 kiloms. of route.

Data of the electrification systems dealt with in these two articles will be found in Table XII.

Low-Temperature Carbonisation and Power Generation.

Whatever the future may bring forth, it can hardly be said that, as yet, the claims of the various and competing low-temperature carbonisation processes to be economically sound, in regard to the aggregate value of the resulting gas, oils, tar and residual fuel products, have been established. At the same time, the production of electrical energy at a power station supplied by gas engines fed with low-temperature carbonisation gas, as at the Midland Coal Products Company's plant at Butterley, and the extremely interesting developments in connection with the use of gas engine exhausts in a carbonisation plant at the Devonshire Works of the Staveley Iron and Coal Company, Ltd., afford examples which no power engineer or fuel technologist can afford to ignore. The cycle of operations which is being carried out at Chesterfield possesses a degree of interest which can hardly be exaggerated, and the details contained in the comprehensive paper read by Mr. David Brownlie on February 17th, at a meeting of the Midland Counties Institution of Engineers, held at the University, Nottingham, will therefore appeal not only to power engineers, but to all fuel technologists as a welcome and informative contribution in the even wider field of fuel economy.

The meeting was well attended, and it is therefore the more to be regretted that a subject of such interest should have led to so inadequate a discussion. The title of the paper and its length were in some measure responsible for this perhaps. "Low-temperature Carbonisation" is a subject which of late has been described *ad nauseam*, although the point of view from which it is discussed in Mr. Brownlie's paper should have sufficed to show that its object differed entirely from the great mass of literature which has appeared of late. At any rate, the author made it abundantly clear, from the outset, that the paper dealt with the subject, not from the point of view of the intrinsic merits or demerits of the innumerable processes at present before the public, but from the point of view of the broad principles involved in the economic utilisation of low-grade fuel in direct conjunction with steam boiler, furnace and power-house practice, aspects which are almost entirely novel, so far as the practical examples given in the paper are concerned. They are, moreover, likely to attract considerable attention in the near future, since it is an open secret that the gas and the electrical interests are, in view of the measures contemplated by the Government in the impending Electricity Bill, seeking mutual co-operation along lines very closely akin to those discussed in the paper; that is to say, by a scheme for linking more closely together the two industries of gas production and electrical power generation. The paper shows the extent to which very low-grade fuels may economically be made to subserve the same ends and the extent to which, in certain instances, they are already doing so. It deserved, therefore, to have been discussed on its merits as a whole, and not on the mere side issues along which the discussion did, as a matter of fact, develop.

Reverting to the paper itself, the author strongly emphasises the fact that steam generation, producer and furnace practice alike are particularly suitable operations for the application of combined low-temperature carbonisation and fuel consumption, if fairly large water-tube boilers are employed to give a sufficient rate of coal consumption per unit. In general, and subject to numerous minor modifications, the principle involved is to arrange that the coal required, instead of being burned in the raw state, is subjected to a preliminary low-temperature carbonisation in a retort or other plant forming a part of the furnace or boiler itself, so as to separate the maximum amount of high-grade—low pitch content—tar, and, if necessary, ammonia, while the residual low-volatile fuel, in a much more chemically reactive and generally efficient condition, is available along with the residual uncleaned gas. Such aspects of low-temperature carbonisation are entirely distinct from processes in which the plant is a separate installation. After quoting the yields in gas, light and heavy oils, ammonia and residual fuel when low-temperature carbonisation processes are employed in conjunction with boiler and furnace plants, the author points out that, assuming that the 17 million tons of coal estimated to be used yearly at colliery boiler plants, were treated in this way, the total production from this source alone in Great Britain each year would be 43,750,000 gallons of motor spirit; 262,500,000 gallons of tar, of which at least 50 per cent. would be suitable for Diesel engines; and 117,000 tons of ammonia sulphate.

Again, the electrical power stations of the country—perhaps at the moment the most suitable of all for the application of this general principle of low temperature carbonisation—with an annual consumption of 8,000,000 tons of good grade coal, would give, every year, about 20,000,000 gallons of motor spirit, 120,000,000 gallons of tar, and 53,000 tons of sulphate, at the expense of about an extra 1,600,000 tons of coal, to retain the same steam output. Many electricity stations of enormous size are now being built, and there will soon be a number of installations at work with a consumption of 500,000 tons of coal per annum, which, in combination with low-temperature carbonisation, represents for each individual station an output every year of 1,250,000 gallons of motor spirit and 7,500,000 gallons of crude tar.

Each of the leading types of low-temperature carbonisation processes, of which there are some 120 extant, and in respect of which many hundreds of patents are in existence, are described in the paper in considerable detail, the subject being discussed under the following general heads:—

(1) The pre-drying of raw fuels before combustion, carbonisation or gasification.

(2) Low-temperature carbonisation in conjunction with mechanically fired furnaces; and

(3) Low-temperature carbonisation in conjunction with pulverised fuel firing.

Of the many processes described, two in particular may be referred to, as they both deal with aspects of the broad question of fuel economy which is at present evoking so much interest and attention. These are the practice at Butterley and at Staveley respectively, of which mention has been made above. The process employed by the Butterley Company, or, rather, by its associated company, the Midland Coal Products, Ltd., has frequently been described. What is of interest in the present connection is that it is one which involves the production of a considerable volume of what may be termed high-grade producer gas, about 53,000 cubic feet per ton, which it was intended to use on the spot, either in gas engines or for firing boilers and other furnaces. The gas is being used with great success in the present plant of the company at Netherfield to drive the electric generators of the power station, which provides light and current for works on the Colwick estates. Four retorts, have been installed, each having a total capacity of 5 tons of briquettes and an output of 96 tons per diem, in the aggregate, together with a by-product plant with all the necessary washers, scrubbers, &c. Two 750 brake horse-power six-cylinder vertical National gas engines, equipped with waste heat boilers, which give all the steam required, have been laid down, and are direct coupled to alternators supplying alternating current at 440 volts. These gas engines only consume the gas from two retorts, and an additional twelve-cylinder gas engine of 1500 horse-power is in course of erection. As an improved and saleable residual fuel is obtained, it is obvious that the plant in question, although small, has features of great interest and promise. It is, moreover, suitable for application to colliery waste and low-grade fuel.

The practice at the works of the Staveley Coal and Iron Company, described at length in Mr. Brownlie's paper, is of far more than mere passing interest, as it marks an important stage in the application of low-temperature carbonisation conjointly with gas engine practice at a power station, and has features which render it unique at the present time. A considerable amount of large-scale experimental work on low-temperature carbonisation has been carried out at the works of the company under the supervision of Mr. Charles Markham ever since 1916. This work has involved the general utilisation of all kinds of refuse colliery material of very low grade and very high ash content—33·5 per cent. The results are now summarised under four heads:—(1) The use of an externally heated pot-shaped cast iron retort, having an internal agitator with the charge at a temperature of about 930 deg. Fah. operated under a high vacuum. (2) A special method of working retorts, as well as most of the cooling and condensing plant, under considerable pressure. (3) The main process—Markham retort—which employs an intermittent vertical internally heated retort, in which the charge is lighted at the top; a carefully regulated supply of air and steam is then passed in at this point and drawn down through the charge. A zone of combustion then travels steadily towards the bottom driving off all the gases and vapours in front of it. These are withdrawn from below, together with the products of combustion. (4) The use of the heated inert gases, including the exhaust of the large 7150 horse-power Cockerill gas engine, as a heating medium for the retort as described in (3), except that the gases replace the steam and air, and carbonise the contents of the retort by their sensible heat.

The new gas engine—described in The Engineer of February 6th, 1925—at the Devonshire Works of the Staveley Company is one of the largest in the world. It is of the double-tandem four-cycle double-acting type, and was supplied by the Cockerill Company of Seraing, Belgium. It operates on blast-furnace gas, cleaned down to 0·02 gramme of dust and 18 grammes of water per cubic metre. At the normal duty of 7150 brake horse-power, the speed of the engine is 91·5 revolutions per minute, corresponding with 7720 B.Th.U. per indicated horse-power, or 12,300 B.Tn.U. per kilowatt, with a mechanical efficiency of 85 per cent. The exhaust for these conditions is approximately 3,500,000 cubic feet per hour at an average temperature of 1110 deg. Fah. (600 deg. Cent.), and contains 20 per cent. of carbon dioxide and 4 per cent. of oxygen. Normally, all these exhaust gases are passed through two Cockerill waste-heat boilers of the horizontal tubular type, with superheaters and feed-water heaters. Each of the boilers evaporates 7050 lb. of water from 194 deg. to 203 deg. Fah. to a pressure of 200 lb. per square inch and a superheated steam temperature of 570 deg. Fah. (300 deg. Cent.). The gas engine exhaust is finally passed to the atmosphere at about 230 deg. Fah.

In the carbonisation experiments the retort charge is about 20 cwt., and part of the gas engine exhaust—at 1110 deg. Fah.—is taken off from the large supply pipe that goes to the waste heat boilers, and passes down through the charge in the ordinary way, the gases and vapours evolved by the carbonisation, mixed with the exhaust, passing out at the bottom to the condensing plant. The circuit includes a mechanical exhauster, vertical pipe condensers, cooling coils with fin attachments at the top half, a gas meter and vertical wash oil scrubbers.

Notes on British Railways by a Continental Engineer.

No. IV.*

Rolling Stock and Wagons.

So as to be quite impartial and to avoid creating any wrong impression, let me make it clear once and for all that the rolling stock of the French main line express trains—whether belonging to the railways themselves or to the Wagons-lits Company—at any rate, the vehicles which have been built during the last years, can compare favourably with similar rolling stock of any other country. It is comfortable, it is carried on bogies, and the width of the loading gauge permits of both compartments and corridors being given generous proportions. Moreover, the coaches are fitted with every modern convenience. The same thing can be said of those on the newly electrified lines, even those serving the suburbs, which closely resemble in form the American type of car. The most recent coaches, whether those of the railways

* No. III. appeared February 19th.

or of the Wagons-lits Company, are fitted up and decorated in a manner which is unrivalled in the rest of Europe. In time there will be sufficient of these coaches to make up some very fine trains, but I am now referring to main line express trains, or to "*voitures de luxe*" of modern design; many of the ordinary trains are at present made up of old pattern coaches.

For the foreigner, accustomed as he is to coaches of greater width, the weak point in the express trains on many English lines is the comparative narrowness of the rolling stock. This defect is entirely forgotten when the eye has noted other dimensions and when several journeys have shown that the shortcoming is less serious than it seemed at first sight to be, and that, moreoever, it is compensated for by other advantages. It is, besides, entirely absent from the trains composed of Pullman cars, while the trains on the Continent which run in connection with the English boat services only comprise, as a rule, coaches of the ordinary present-day type, those designated "*de luxe*" being reserved principally for the trains running from Paris to the South, or for certain trains themselves called "*de luxe*"; for instance, the "Blue Trains." That said, it must be admitted that if the coaches of the British expresses seem, on some of the lines, to be, by comparison, of rather scanty proportions, at least they differ little, if at all, from the coaches used throughout on all the lines, so that they constitute a remarkably homogeneous whole. One is therefore led to the same conclusion as with the permanent ways and signalling: standardisation, as great a uniformity as possible, and the almost entire disappearance of out-of-date rolling stock. In a word, there is a much less marked difference than in other countries between the coaches of important expresses and those running on other services, even on branch lines. On the Continent the handsome *de luxe* coaches are relatively few in numbers, at any rate at the present time, while many of the English companies can put in service for special occasions, such as race meetings, Bank holidays, &c., a considerable number of supplementary trains, *all of them composed of up-to-date bogie coaches*; their reserves of rolling stock seems enormous. If we disregard for the moment cutside appearance, the *de luxe* coaches—except the Pullmans—are perhaps slightly inferior to similar coaches in other parts of Europe; but, on the other hand, only modern type coaches are found everywhere, and that is nothing new. As long ago as at the Paris Exhibition of 1889 the Midland exhibited a long third-class bogie coach, which, though it was a remarkable vehicle for the period, was only an example of the rolling stock which that company was actually using. In short, for that, as for everything else: an excellent average.

It can even be said that, up to a certain point, the narrowness of the British running gauge has actually been an advantage to the travelling public, for whereas in the slightly wider coaches on the Continent four passengers have to sit side by side in each first-class coach, on British railways there are only places for three, and consequently the seats are more roomy. The inconvenience only began to be seriously felt on British lines when the lateral corridor was introduced, and when some companies endeavoured to continue to have three seats a side.

I also think that to some extent the easy running of the British coaches is due to there being less overhang of the coach bodies, which project less over the underframes than do coaches on the Continent or in the United States of America.

I cannot praise too highly the little sleeping compartments on the English lines—for example, on the night trains running to or from Scotland, in which the traveller is entirely isolated from the rest of the passengers, and which are in marked contrast with the promiscuousness of the American cars, which, however, is indifferent to dwellers on the other side of the Atlantic. Moreover, the charge for a sleeping berth is relatively small. Unfortunately, such coaches, while they offer the maximum of comfort to those travelling by night, are but little use on very busy lines and can only be used in Great Britain, between London and Scotland, because there are three trunk lines running from the Metropolis to the North.

A similar remark may be applied to the first-class dining cars, which are models of comfort, but which can only accommodate a very limited number of passengers at a time and would not have a sufficient capacity for very crowded lines. Without any pretence, and though not being labelled as *de luxe* cars they can truly be called so, for it is the main aim in such vehicles to avoid crowding. Their carrying capacity would be inadequate on the main continental traffic arteries, but it must not be forgotten that on many lines they are duplicated, on the same trains, by third-class dining cars—which do not exist anywhere else in Europe—but which, on the contrary, are frequently crowded, for their narrowness only allows to each passenger a very restricted width of seat. But, in any case, they provide a restaurant for third-class passengers, who get well served at a price which is within the reach of those of modest means. Still another instance of happy democratisation.

Some trains include Pullman cars or are entirely made up of them. All the fairly quick and direct passenger trains are now composed of vestibuled stock, as in France and America, but of the English type. Let me add that, owing, to some extent at least, to the small distance between the coaches, the bellows-like couplings for the gangways between the vehicles are much simpler than in France or the United States.

In England some carriages are fitted with coupling arrangements of the combined type, being furnished with side buffers as well as with a central coupling, which permits of the coaches passing from one system to another very quickly. The central coupling has many advocates, and its use may, very possibly, some day become more general for passenger stock.

Before leaving this subject, I cannot allow to pass without mention the particularly elegant and compact appearance of trains made up entirely of coaches all of the same height and width, and with but little space between them, with moulded outside panelling, well varnished, often gilded, and all alike, and of the same colour, no matter of what class they are. The uniformity is even extended to the luggage vans, which have the same panellings, and the same mouldings, and with no projections. All the trains are clean and well washed. A stranger feels all the time that he is in a country where the inhabitants like their railways, which, moreover, seeing the way in which they penetrate into the centres of towns, are more intimately mixed up with the lives of the people than they are in other countries at the present day.

Another reason for making the coaches of each line all alike, may be the desire of the different lines to have their own stock readily distinguishable at sight.

Whatever may be the cause, this compactness and uniformity are essentially British in character. I might mention as good examples of this quiet elegance and pleasing regularity in appearance—which, I may add, also extends to the engines—the trains of the Midland, Great Western, Caledonian and many other lines.

This studied elegance is far from being a secondary or superficial consideration; it is evidence of a very praiseworthy ideal, which extends in many directions and engenders in the public a desire to make use of the railways and in the servants a determination to give good service.

Moreover, from a technical standpoint, the uniformity of British trains, and the absence of projecting parts, as well as the smallness of the space between the coaches, certainly tend to reduce the air resistance when the trains are in motion, just as the levelling of the roads and of the joints in the rails tends to lessen the resistance to traction per ton of the vehicles.

Inside, the coaches are decorated simply and in good taste. The first-class compartments display a sober elegance which is most pleasing and carefully designed—polished hard woods, lincrusta, gilded mouldings—the general effect being to suggest more warmth and brightness in colouring than the everlasting drab grey of the French vehicles or the velvets of the German coaches. The seats are generally covered with a carpet-like material and well padded. The third-class coaches, without a single exception, have comfortable padded seats, but it must not be forgotten that in England the second-class coach is now only retained on the Southern lines which run in connection with continental services, and that the very great majority of the public travels third class. The windows of the compartments are, without exception, glazed with plate glass, and never, as elsewhere in Europe, with ordinary sheet glass.

Each of the coaches has, normally, two compartments at least reserved for smokers, and one, at any rate, for ladies only. Considerable use is made of composite coaches, comprising both first and third-class compartments, and sometimes a compartment for luggage as well.

The coaches are clean and kept in an excellent state of repair. On the Great Western I have noticed an automatic apparatus by which the whole of the exterior of a train can be washed in a few minutes. It can, however, only be used when all the coaches are of the same width and outside shape.

British engineers only used two axles for the very antiquated three-compartment coaches. As soon as the bodies were lengthened, a third axle was added—as the P.L.M. in France used to do—and a large overhang at the extremities was never permitted. Then came the four-axle coaches, as, for example, those on the old Great Northern or London and North-Western. The English engineers never entertained the simple idea, which reigned supreme from one end of the Continent to the other during the last generation, that the lengths of two-axle coaches could, so to speak, be increased indefinitely by increasing the overhang, so that the wheel base might not exceed a permissible figure. One has only to have travelled in such coaches, especially on fairly fast trains, and in the end compartments, to realise the advantages attaching to bogies. The fear of deadweight in the minds of the traffic managers of certain neighbouring countries led to the commission of regrettable errors, and the number of these very long two-axle coaches still remains high, and they will continue to be employed for a long time yet.

Moreover, for some inexplicable reason, the bogie was subjected throughout Europe and even in England to prejudices which are to-day incomprehensible. For many years the L. and N.W. and the Great Northern used four-axle non-bogie coaches, which, though they rode smoothly enough, did not, in spite of the sideplay given to the axles, negotiate curves as well as if they had had bogies, which latter are much better able to damp out vertical shocks. In short, the bogie, though it has had such an uphill climb to make on the Continent of Europe, has at length acquired the favour it merits, and it is now generally employed in new stock. It has been used for a long time in England, but we should remember, I think, that the Wagons-lits Company was the first in Europe to apply it to all its vehicles.

But the British railways, after the bogie was introduced, applied means of circulation between the vehicles, and formed corridors in the long coaches of their express trains, but did not alter the arrangement of the coach bodies themselves while the influence of American construction made itself felt in Europe. They have generally retained, excepting on the Pullman cars, the side doors which allow of quicker and easier ingress and egress than is possible with only two end doors. The latter arrangement, which permits of the coaches being lighter, was, I believe, first adopted on the Continent for long bogie carriages by the Italian State Railways, which managed to hit upon a type of coach that was, relatively, very light indeed; then it was taken up by several French lines, which still continue to give their express coaches the two end doors, because they have greater confidence in their strength. In fact, the use of the American system in which the sheet metal body forms a sort of girder is destined to spread, in France more particularly. Coaches with only two end doors offer the maximum of rigidity, and they have been adopted, with bogies, for lines recently electrified. All the same, some of the latter have one or two sliding side doors, which facilitate getting the passengers in and out, but their rigidity, while it is sufficient, is by no means so great. The electrification of the Paris suburban lines will be carried out gradually by means of similar vehicles, which will permit of the reconditioning of the old stock, which is very much out of date, and which would have been remodelled long since had not the war, first of all, stopped, and then greatly retarded the work which was already in hand.

Some of the British railways have adopted the vacuum brake and some the Westinghouse. That has necessitated the fitting of coaches, which have to circulate over several systems, with both types of brake gear. The vacuum brake is very simple in construction, can be applied very gently, and is readily controllable. The rapidity of the propagation of the braking effort is not very high, and the system is admirably suited for trains of moderate length, such as are commonly used in England. In any case, on all the British railways, the stops are made gently and without shock, which goes to prove that the drivers have a good "touch" and that the gear is kept in good order.

Goods Wagons and Trucks.

The British companies have remained faithful to the small, low capacity wagon, which is in great contrast, not only with the huge American wagons, but with those which are normally used throughout the rest of Europe. The foreigner is also surprised at the large proportion of open trucks.

This practice, which appears, *a priori*, to be the result of old time custom, is quite defensible from certain points, though it can really not be regarded as a model which it is desirable to follow.

As concerns the transport of coal, it must not be forgotten that the retention of the small wagon is necessary by reason of the limited capacity of the cranes and tipping gear at some of the ports, Cardiff, for example.

The use of open trucks for general merchandise allows of quick unloading, and renders the discharge of heavy goods by crane more easy. It is certain that both in the United States and on the European Continent the covered wagon is used to excess. Covered wagons require more labour for loading and discharge, especially in the case of the immense American vehicles. I have no desire to apologise for a custom, which is certainly open to criticism; at the same time, account must be taken of circumstances and methods of working. It must not be forgotten that, on the British lines, the goods are in the trucks for a much shorter time than they are elsewhere; the *régime* of *petite vitesse*, and the detention of goods for indefinite periods in goods yards, are unknown. The stations are not used as warehouses. For example, goods loaded at Glasgow one morning are delivered in London, and are even carted away to their destinations, at latest by the evening of the following day. Under such conditions, even in a rainy climate, the carriage of goods in open wagons covered with tarpaulins presents no difficulty. It matters very little if the trucks are small as long as the customer gets quick delivery.

For all that, generally speaking, transport by low capacity wagons is less economical than it is by larger vehicles, and it entails the hauling of a higher proportion of dead weight. That is a matter which has been less studied by British companies than by foreign managements. It must, however, be admitted that the goods service is excellent, and very quick, and that there is but little congestion in the goods stations, where work is normally very brisk, as it may well be seeing the equipment and the staff

provided. In the same way, by reason of the quick circulation of the rolling stock, shortage of wagons is less felt than it is in countries in which the vehicles remain idle for weeks, or even months at a time, in the goods sidings or in distant countries. The British wagon remains in Great Britain and quickly returns to its starting point. Is it not strange that, in a country like the United States, where there are such numbers of high capacity wagons, the shortage of wagons should be so frequently and severely felt. Furthermore, in the United Kingdom, the "rushes" of seasonal products are felt to nothing like the same extent as in countries which are almost entirely agricultural. The mineral traffic is much more constant than is that in agricultural produce; it varies, certainly, with the seasons, but very much less brusquely. In short, the problems to be faced are less complex than they are in other countries by reason both of circumstances and customs.

If the passenger coaches are built and maintained with the care to which I have drawn attention, the goods rolling stock has retained its simple and rudimentarily crude character, and it has done so all the more because a large proportion of the vehicles are privately owned, especially by the mining companies. Compared with the British goods truck, the large continental wagon is a very complicated affair. For example, the latter has screw couplings, the placing and screwing up of which takes a considerable time, even if they are not fully tightened; in which case they have no value. The screw coupling on vehicles which are not fitted with power brakes is useless. When, in consequence of the war, British wagons first made their appearance on the Continent, they were first of all regarded as being clumsy and out of date. But, after they had been in use for some little time, many of the French shunters formed a high opinion of the simple link couplings which could be attached and detached from the side of the wagon, whereas with the screw coupling the shunter is obliged to get in between the vehicles. The link coupling is one of the reasons why shunting is so quickly done in England.

It seems to me, on the other hand, that it is necessary to keep within moderate bounds the weight of British goods trains, which are often only braked by the engine and by the van at the rear, whereas continental trains have several look-outs and brake men, and even specially heavy brake vans, but the engine whistle is not always heard at the rear of very long trains.

In this respect the Americans have solved the problem in a particularly complete manner, by fitting nearly all the vehicles with the Westinghouse automatic brake, which allows very long and comparatively rapid trains to be employed on lines with heavy inclines. Elsewhere, and even in France, by employing very powerful locomotives and several brake vans, very heavy goods trains can be run at speeds exceeding 34 miles per hour.

To sum up, it is unwise in railway matters to criticise unduly an existing organisation which has been in satisfactory operation for a long time. It is true, and it cannot be repeated too often, that in railway matters the various problems to be solved are much less complicated in England than in certain other countries.

Institution of Mechanical Engineers

ON Friday evening last week the seventy-ninth annual general meeting of the Institution of Mechanical Engineers was held in London under the chairmanship of Sir Henry Fowler, senior vice-president. Subsequently Mr. E. G. Herbert, of Manchester, presented a paper entitled "The Measurement of Cutting Temperatures."

In the course of the preliminary proceedings Sir Henry Fowler announced that the Council had elected Sir John I. Thornycroft an honorary life member of the Institution. Sir John has been a corporate member for fifty years.

We give below a summary of the Council's annual report. There was no discussion on it of any moment. Mr. Brewer at some length suggested that the time was ripe for the Institution to take some steps to improve the status of mechanical engineers, but beyond favouring the closing of the profession along the lines adopted in the medical, legal and other callings—a suggestion which Sir Henry Fowler subsequently deprecated strongly—he had nothing, so far as we could discover, of a constructive nature to submit. Captain Edgar Smith raised a question regarding the Institution's contribution of £50 towards the fund being raised for the purchase of the ss. Simla model engines. Mr. Pendred, dealing with the subject, stated that the model would eventually be removed to the Kelvingrove Museum, Glasgow, and that of the sum required to effect the purchase, namely, £400, so far only about £200 had been collected.

At the conclusion of the business of the annual meeting Mr. William Reavell, of Ipswich, assumed the presidential chair, in succession to Sir Vincent Raven, who is at present in India on Government business.

ANNUAL REPORT OF THE COUNCIL.

The Council's report showed that during 1925 there was a net gain of 220 in the membership roll, bringing the total number of members up to 9805. The financial statement exhibited a total expenditure of £33,835 4s. 1d. and a revenue of £33,963 9s. 7d. On the expenditure side £1198 2s. 7d. was incurred in connection with research work. The statement of revenue included a sum of £1000 transferred from the general reserve fund towards meeting the cost of publishing the Marine Oil Engine Trials reports. The Institution examinations involved an expenditure of £1490 8s. 6d., of which sum £1066 5s. 6d. was recovered by way of examination fees. The National Certificates and Diplomas in Mechanical Engineering awarded by the Institution in conjunction with the Board of Education entailed a net expenditure of £439 14s. In England and Scotland 1528 candidates attended the national examinations, and among them 875 certificates and diplomas were awarded.

Under the heading of research, the Council reported that for the Alloys of Iron Joint Research Committee work was continued at the National Physical Laboratory under Dr. Rosenhain. Small melts of pure iron were obtained and series of pure chromium-iron, manganese-iron, and phosphorus-iron alloys were prepared, while crucibles and other refractory articles suitable for the research work were produced. For the Hardness Tests Research Committee work was also continued at the National Physical Laboratory under the charge of Dr. Stanton. Experiments conducted with diamond cones showed that such cones can be used for accurate and reliable hardness tests on hard materials which cause the ball used in the Brinell test to flatten. Under the direction of Professor Stoney, acting for the Steam Nozzles Research Committee, work was conducted at Manchester on the conversion of the nozzle tester to deal with higher pressures than those hitherto used and on the design and installation of a gas-fired superheater for 8000 lb. of steam per hour. New nozzles, nozzle boxes and cages were constructed. For the Wire Ropes Research Committee Dr. Scoble, at Woolwich Polytechnic, investigated the characteristics of 1in. circumference ropes made from wires of high tensile strength.

THE MEASUREMENT OF CUTTING TEMPERATURES.

As there was a possibility of the subject of Mr. Herbert's paper being anticipated abroad, it was published in the Institution's *Journal* at the beginning of the year. The substance of the paper was given in our issue of January 1st. It may be recalled that Mr. Herbert measures the temperatures generated when a metal is cut by a tool by making the work and the tool two elements of a thermo-couple. The tool is insulated from the slide rest or tool-box by mica strips, one lead to the millivoltmeter or other measuring instrument being connected to the tool and the other to any convenient part of the machine. For non-ferrous metals tools of ordinary steel are used. For cutting steel stellite tools are generally used, since stellite is a non-ferrous alloy. Even, however, ordinary steel tools can be used against mild steel, the electromotive force produced by such a couple being quite sufficient for temperature measurements, and in many cases actually higher than that given by a stellite mild steel couple. The couples were calibrated in an electric furnace against a standard iron-constantan couple. No difficulty was experienced in using oil as a cooling liquid between the tool and the work, but if water or an aqueous cutting compound were employed a galvanic current was set up. This current, it was found, could be avoided by smearing the tool thickly with tallow.

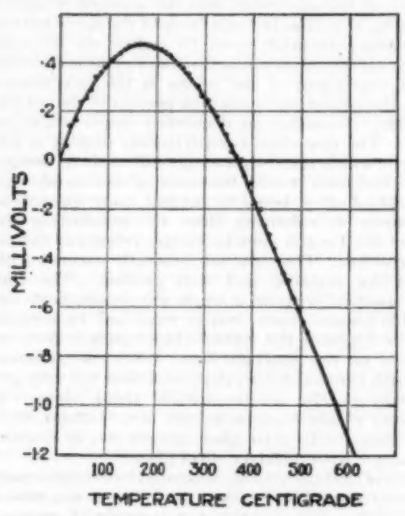


FIG. 1—CALIBRATION CURVE, STELLITE-STEEL COUPLE

The electromotive force generated was measured by means of a unipivot millivoltmeter or, when rises and falls of temperature occurring within a small fraction of a second were being studied, by means of an Einthoven string galvanometer. With the latter instrument an arrangement was devised for obtaining a permanent photographic record of the temperature indications. In our issue of January 1st we illustrated the photographic arrangement and reproduced some of the thermographs obtained with it.

A typical calibration curve of a stellite-steel couple is given in Fig. 1. It will be observed that the voltage reaches a maximum value at about 170 deg. Cent. and reverses its polarity at about 370 deg. It would appear at first sight unfortunate that the curve is not of a straight line character, for with its actual form there must be some indefiniteness in the temperature indications near the apex and in addition any positive voltage corresponds to either of two temperatures. The parabolic form of the calibration curve did not, however, give rise to any great amount of ambiguity and was actually found to be advantageous in that, for reasons explained in the original paper it enabled any partial short circuiting of the couple—as by clogging of the tool with chips—to be readily detected. One effect of the parabolic form of the calibration curve is clearly shown in most of the thermographs accompanying the paper. If the temperature generated by the cut exceeds the turning point of the calibration curve the record produced will show two peaks side by side, the first indicating the attainment of the turning point temperature while the work is heating up and the second its attainment during the subsequent cooling. The maximum temperature attained is indicated by the foot of the trough between the two peaks and is given by some point on the right-hand branch of the calibration curve. If there is only one peak the implication is that the temperature reached is less than the turning point of the curve.

Some additional information not in the original paper, but of great interest, was communicated to the meeting last Friday by Mr. Herbert. Brief reference was made in the paper to a method of investigation employing a surfacing cut on the end of a bar. As the tool travelled from the centre outwards or *vice versâ* there was a gradual uniform change in the cutting speed. The temperature graph obtained from such a test should be a smooth curve if the metal is uniform and if its machinability is not affected by any of the temperatures generated by the cutting action. If, however, at any point the resistance of the metal to the action of the cutting tool increases or decreases, the fact of its doing so should be indicated by a peak or depression in the voltage curve. Many records of this description were made at first with the string galvanometer and afterwards with the millivoltmeter. With the latter instrument readings were made every five seconds. The sluggish nature of the millivoltmeter was found to have the advantage that it averaged out the rapid fluctuations produced by the breaking up of the chip, vibration, and other accidental causes.

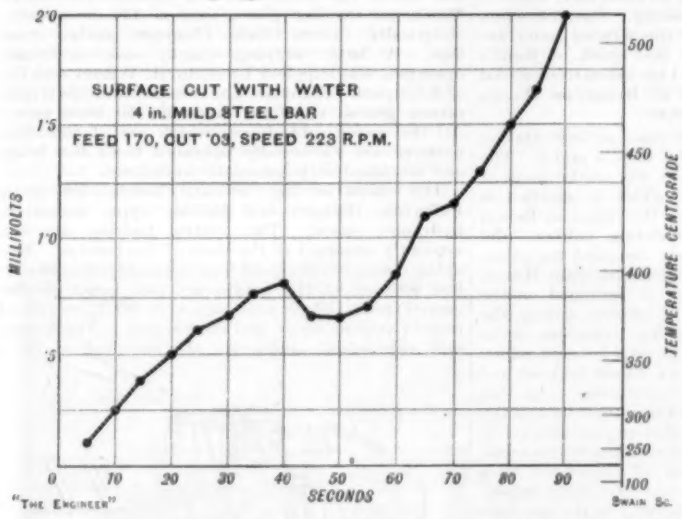
Two typical graphs obtained with this method of experimenting are reproduced in Figs. 2 and 3. Only one explanation, in Mr. Herbert's opinion, can account for the interrupted rise in the curves. As the cutting speed is increased, a "free cutting" range of temperature is reached by the steel over which its resistance to cutting declines. Fig. 4 shows one of the mild steel test pieces. The bright ring called a "Whitaker ring," after the assistant who first called Mr. Herbert's attention to its significance, corresponds with the depression in the voltage curve. The diameter of the ring can be increased or decreased at will by decreasing or increasing either the lathe speed or the depth of cut. This ring is familiar to all turners, but so far as Mr. Herbert is aware, its significance has not hitherto been investigated or explained. The ring can be produced in all crystalline metals from tin to tool steel. Under the microscope—see Fig. 5—the ring is found to have a freely cut, smoothly finished surface, which contrasts with the plucked and torn surface on either side. The character of the chips produced from the ring and from the portions inside and outside it is different, as is well shown in Fig. 6.

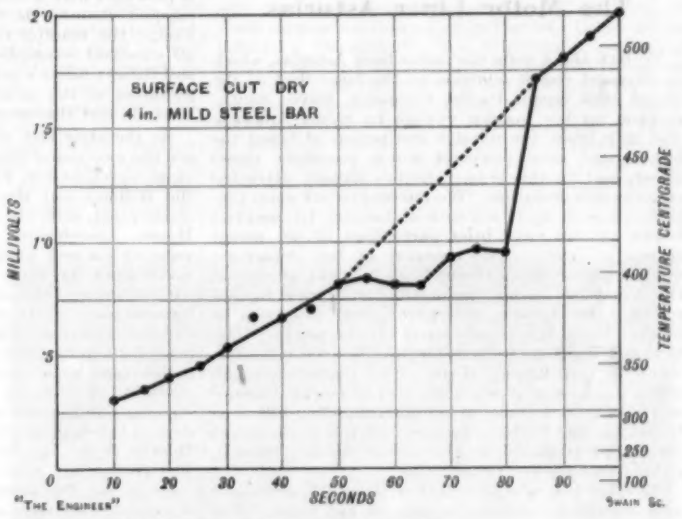
Mr. Herbert explains the phenomenon in terms of the work-hardening capacity of metals. With his pendulum hardness tester he measured this capacity by taking successive "scale" hardness tests on the same spot on the specimen. Making the tests with the specimen heated to different temperatures, he obtained the curves given in Fig. 7. The deep depression marked D 2, occurring between 100 deg. and 150 deg. Cent., shows that at this range of temperature the metal does not work harden to the same extent as it does at lower and higher temperatures. This depression, according to Mr. Herbert, coincides with the "free cutting range" of temperatures. Metal cut within this range is only slightly hardened by the action of the tool, with the result that it cuts freely, leaving a smooth finish, less heat is generated, a flowing helical chip is produced, and a bright Whitaker ring is formed. In Fig. 7 three depressions, D_1, D_2 and D_3 are shown in the work-hardening capacity curve. Three corresponding Whitaker rings are sometimes found on the work.

Mr. William Taylor, called upon to open the discussion, remarked that Mr. Herbert's paper provided an excellent illustration of what the Institution was doing for its members. The difficulty which chiefly faced most engineers to-day was to discover some method of reducing costs of production without lowering wages and salaries. Since the cutting of metals constituted about 90 per cent. of the work carried out in the average engineering establishment, Mr. Herbert's paper dealt with a very important factor affecting production costs. Briefly tracing

Mr. Herbert's contributions to engineering science, from his tool steel testing machine to his pendulum hardness tester, he remarked that the beautiful experiments described in the paper submitted that evening opened the way for us to discover what happened when metal was cut, to gain knowledge which we ought to possess but did not. Since the days of his boyhood, he continued, he had been familiar with the Whitaker ring, but until he heard the beating of the human heart, to record the temperatures occurring inside a gas engine cylinder, and to detect explosions and noises occurring at a great distance, but never before, so far as he knew, had it been employed for the purpose to which it had been put by Mr. Herbert. In the diagrams given by the galvanometer minute vibrations were always present. Mr. Herbert seemed to suggest that these vibrations were due to variations in the cutting temperature, investigated the cutting temperatures generated at the edges of deep holes, or whether such an investigation presented an insuperable problem.

Mr. Herbert, replying to the discussion, stated that Mr. Taylor's remarks regarding the effect of many small reductions as opposed to one large reduction seemed to be further illustrated by the fact that thin chips taken with a cutting tool were hardened to a greater extent than thick chips. Dealing with Pro-





FIGS. 2 AND 3—THERMO-COUPLE RECORDS OBTAINED DURING THE SURFACING OF THE END OF A STEEL BAR

Mr. Herbert's explanation of it he had never appreciated its significance. Regarding the work hardening of the metal being cut under the action of the tool, he recalled enquiring when on a visit to the works of the British Aluminium Company, whether the metal was hardened most by successive small reductions

FIG. 4—WHITAKER RING ON STEEL BAR

or by one large reduction, and was told by undoubtedly successive small reductions. That fact was in keeping with Mr. Herbert's results, which showed the economy to be derived from taking large cuts. It was also borne out by practical experience in the sharpening of saws. If light cuts were taken, the

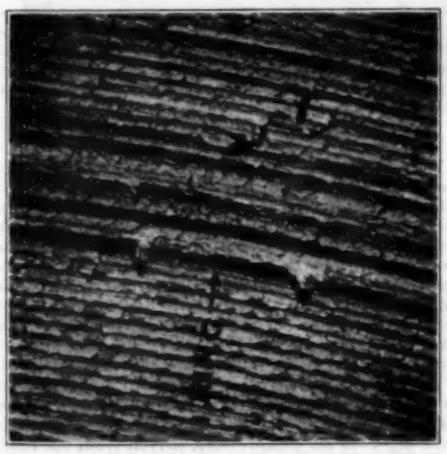


FIG. 5—MAGNIFIED VIEW OF RING

file quickly became worn, while with heavy cuts it would last a long time.

Professor E. G. Coker remarked that the Einthoven galvanometer was an instrument capable of the most varied application. It had been used to investigate but he himself felt that they might be caused by some effect within the galvanometer. Dealing with the calibration of the thermo-couples, Professor Coker remarked that Mr. Herbert was limited in his choice of elements by the fact that one of them had to possess the power of cutting the other. That fact lay at the root of the form assumed by the calibration curve—see Fig. 1 herewith—and was the cause of the existence of the point of inversion and the double-value difficulty to which it gave rise. It would be better, he argued, to remove that difficulty rather than strive to convert it into an advantage, as Mr. Herbert had done. It was not, however, easy to see how the difficulty could be removed. No benefit was to be derived by applying a steady electromotive force to the couple, while the insertion in the circuit of an inverted stellite-steel junction placed in, say, a bath of aniline, would not enable the experimenter to work wholly on the straight right-hand portion of the calibration curve, but would simply displace the curve over to the right without affecting its parabolic form. It might be possible to do some-

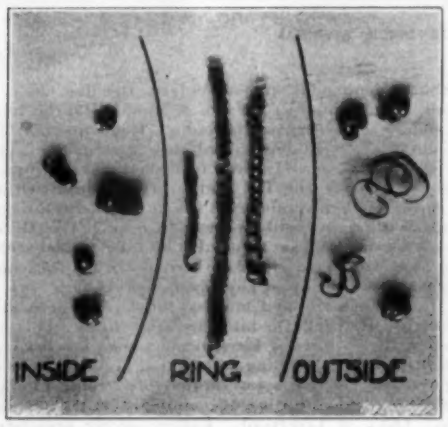


FIG. 6—CHIPS FROM END OF BAR

thing with a thermo-couple formed by inserting a wire of suitable metal into the nose of the tool.

Mr. J. H. Hyde, of the National Physical Laboratory, criticised Mr. Herbert's interpretation of his temperature records, and remarked that it was unfortunate that the galvanometer gave such a wide band for the zero line. The range of temperature covered by that band was ± 70 deg. Cent. Again, as regarded the vibrations at the peaks in the record, he argued that a mean should be struck between the crests and the troughs. He was surprised to find that Mr. Herbert had joined one terminal of the thermo-couple circuit to a point on the lathe bed, for by so doing the spindle of the lathe formed part of the circuit. Such a course, he himself had found, introduced an element of resistance at the spindle, which had to be taken into account in interpreting the readings given by the galvanometer. It would, he contended, have been better to have attached a copper disc to the spindle, and allowed it to dip into a mercury trough.

Mr. F. E. Robinson asked the author if he had fessor Coker's remarks on vibration in the galvanometer records, he said that two causes mainly contributed to their presence, namely, the passage of carts along the road outside his works and the presence of a line shaft with a bearing on the wall of the room in which the galvanometer was set up. As far as possible, quiet times were chosen for the experiments. Nevertheless, he had sometimes suspected that there were vibrations in the electro-

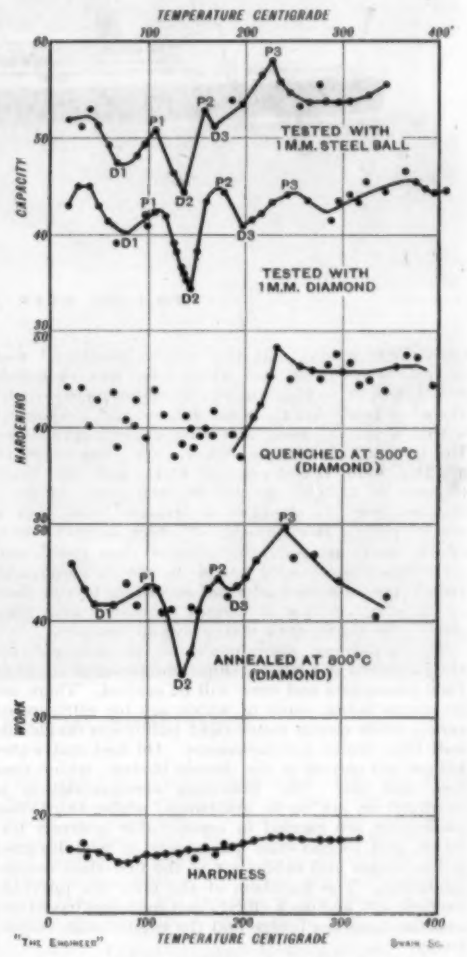


FIG. 7—WORK-HARDENING CAPACITY CURVES

motive force arising from some instability in the thermo-couple itself. Replying to Mr. Hyde, he said that the width of the zero line in the thermographs was not caused by vibration, but represented the width of the slot through which the light penetrated to the photographic plate. In effect the slot moved at right angles to its length, giving a broad band, until the temperature rose when the slot moved parallel with its length and gave a sharp line. There was a

great deal of contact between the lathe spindle and its bearings, and he did not think the resistance at that point was comparable with that of the galvanometer itself. In reply to Mr. Robinson, he stated that experiments on the temperatures produced during drilling operations were very difficult to carry out.

The Motor Liner Asturias.

TO-DAY about noon the motor liner Asturias, which is the most recent addition to the large fleet of the Royal Mail Steam Packet Company, leaves Southampton on her maiden voyage to South America. The ship bears the notable distinction of being the largest and most powerful motor passenger vessel afloat, and for this reason she has already attracted considerable attention. We referred to her main propelling machinery in our issue of January 1st, and two weeks ago we gave brief particulars of her recent successful trials. The occasion of her departure, however, from these shores is an incident of note in the annals of marine engineering, and some further reference to the ship and her engines may now be made. Many fine vessels have left the yard of Harland and Wolff, at Belfast, but the Asturias is an outstanding ship among them. The photographs we reproduce to-day give a good idea of her appearance and of the arrangement of her main engines; but it is to be regretted that no drawings of the engine-room lay-out are available, as the owners do not desire to publish them at the present time.

The Asturias was launched on July 7th, 1925, and was completed about the end of last year. The measured mile trials at Skelmorlie and the cruising trials both showed that her performance was

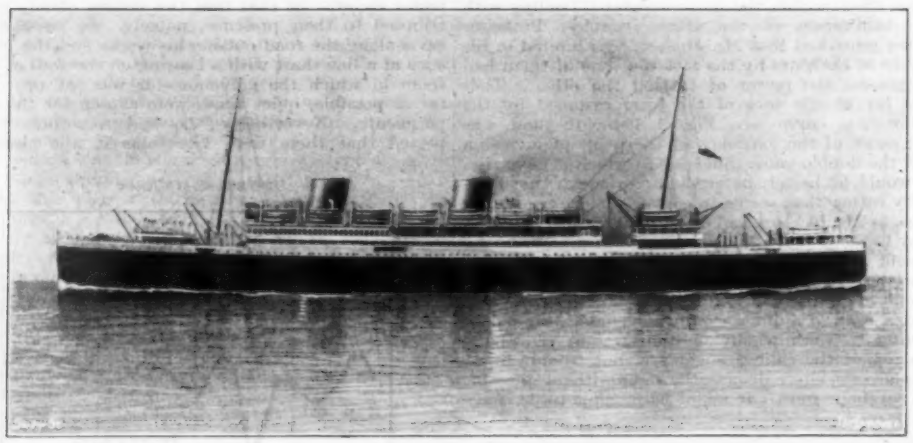


FIG. 1—THE R.M.S.P. MOTOR LINER ASTURIAS

most satisfactory, and the power developed was in excess of that for which she was designed. She was built to conform to the requirements of the Board of Trade and the Spanish laws, and is equipped with the latest safety and navigational appliances. Her overall length is 655ft. 8in., her breadth of 78ft. and her depth of 45ft., and the gross tonnage of 22,500. As will be seen from the illustration, Fig. 1, she has a straight stem and a cruiser stern. Her funnels—of which only the after one is used—are somewhat shorter than usual, and their squat appearance has given rise to comments, both favourable and adverse, according to the taste of the observer, but it cannot be denied that they give to the ship quite a distinctive appearance.

The passenger accommodation is arranged for three classes, and a total ship's complement of about 1800 passengers and crew will be carried. There are six cargo holds, some of which are for refrigerated cargo, while eleven water-tight bulkheads divide the hull into twelve compartments. Oil fuel and water ballast are carried in the double bottom, which runs fore and aft. The first-class accommodation is arranged on six decks amidships, whilst third-class passengers are carried in comfortable quarters forward, and second-class passengers in well-designed public rooms and cabins aft of the first-class accommodation. The members of the crew are provided for right aft, and deck officers and engineers have their quarters near the bridge and the engine-room respectively.

In the four illustrations opposite, some views of the chief public rooms are given. Fig. 3 shows the first-class entrance which communicates with the forward staircase running through the six decks, A to F. Both the entrances, lounge and the stairway itself are pleasing in character, and they are treated in Georgian style.

Fig. 4 is a view of the first-class dining saloon on A deck looking forward. This apartment has a total length of 94ft., with an extreme width of 74ft. and the centre portion, which is two decks or 17ft. high, has a maximum length of 60ft., with a width of 40ft. Seating accommodation is provided for 412 passengers at small tables, arranged for two to twelve persons. A general decorative scheme in the French Empire style has been employed, and fine effects have been obtained with the marble columns, the moulded ceiling, and the good arrangement of bronze electric light fittings. Another important public room is the social hall, which we do not illustrate. It is a well-lighted, richly furnished apartment, and it is provided with a stage at the forward end, whilst a parquet floor is laid for dancing. The first-class lounge, the reading room and the writing room are all excellent examples of the best work of Kent's and Robert Adam's periods, and are taken from actual examples of the artists' work at Houghton House, Norfolk, and Harewood, Yorkshire.

At the after end of the first-class accommodation are the two rooms illustrated by Figs. 5 and 6. The view reproduced in Fig. 5 shows the smoke-room of the William and Mary period, which is panelled in cedar wood, after the manner of the rooms at Belton House, Lincolnshire, where Grinling Gibbons did some of his best work. A finely designed fire-place, taken from the Blue Drawing-room at Ham House, with Grinling Gibbon's carving, is arranged on the forward side of the room. The plaster ceiling, the cut-glass electroliers and the walnut furniture of the period, all go to make a very comfortable room, which is light and well ventilated, and should be cool and pleasant, even under tropical conditions. Another striking public room is the winter garden on the top deck of the ship, which is decorated in quite effectively Moorish style. Fig. 6 is from a view taken in this room. The rooms last referred to are all connected by a staircase at the after end of the first-class accommodation. We may also briefly refer to the specially decorated children's play-room, and to the large swimming bath below on the orlop deck. The cabin accommodation, particularly the first-class, is well planned and is fully in keeping with the high standard set in the public rooms. Reference may be made to the second and third-class apartments. The second-class rooms are well furnished and the dining saloon extends the full width of the ship. Other rooms include a verandah, a smoke-room and a social hall, with a spacious promenade deck. The third-class accommodation forward is on a very good scale, and generous provision has been made for the comfort and well-being of passengers in this class.

In between the first and second-class accommodation are the galleys, kitchens and stores. A very complete selection of kitchen machinery has been installed, and the cooking and baking apparatus are of the latest electric type supplied by John Phillips and Co., Ltd., of Glasgow, and Henry Wilson and Co., Ltd., of Liverpool. Labour-saving apparatus and heaters have been freely used both in the kitchen and the dining saloons. There is a well-equipped laundry arranged aft, the machinery for which was supplied by Thomas Bradford and Co., Ltd., of Manchester.

Reference may here be made to the passenger and service lifts and hoists, of which there are seven. The wireless telegraph, telephone and bell systems are also of the most modern type, whilst efficient fire-fighting apparatus has been installed throughout the cabin, machinery spaces and holds, of the Clayton and Firefoam types.

Among the navigation apparatus we noted new engine-room telegraphs by Siemens Bros. and a Star-Port helm indicator of the O'Neil type, showing at any time by visible signals the position of the rudder. The bridge is fitted with Kent's clear view screens, and the compasses and a sounding machine were supplied by Kelvin, Bottomley and Baird, Ltd., of Glasgow. An interesting sounding instrument in the chart room is the Echo Receiving Gear, Admiralty system—which was described in our Supplement of November 20th last—supplied by H. Hughes and Son, of London. Here is also the master clock for the Pul-syn-etic time system of clocks, fitted throughout the ship by Gent and Co., Ltd., of Leicester. The syrens are of the compressed air and steam types, electrically controlled, and the former is fitted with the Sperry white smoke plume attachment for making a visible as well as an audible signal.

Other deck machinery includes the Welin type davits and Vangunco boat-lowering gears for the lifeboats and motor boats. The larger deck auxiliaries include a 75-kilowatt emergency generating set, placed well above the water line; a Harland-Hele-Shaw-Martineau steering gear; and a 136 horse-power electrically driven Clarke Chapman anchor windlass. A large warping winch, also electrically operated, was supplied by John H. Wilson and Co., of Liverpool. Right aft are two Harland electrically driven geared capstans, each of 150 horse-power. All the water-tight doors—which are of the Stone pattern—are electrically operated from the bridge and are fitted with automatic indicators.

The cranes serving the cargo hatches are of the Fullerton, Hodgart and Barclay type, worked by hydraulic power. The control handles are conveniently arranged at the sides of the hatches. Most of the cranes are designed for a normal load of 30 cwt., but forward of the bridge are two larger double-geared cranes, which are designed to lift 2½ and 5 tons respectively in single and double gear. The heating and ventilating appliances are designed so as to

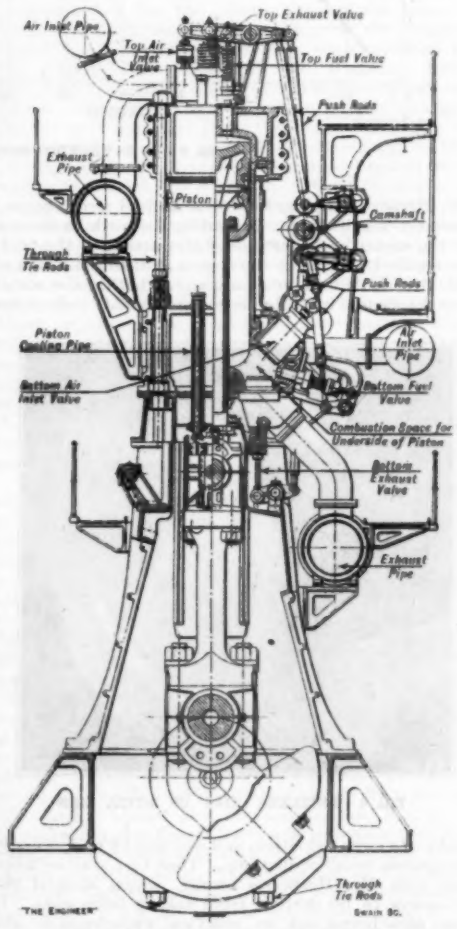


FIG. 2—MAIN ENGINE—VERTICAL SECTION

make the ship comfortable in the cooler home waters, as well as in tropical climates. Electric heaters of the vapour heater type are employed for cabin use generally. For ventilation over fifty large fans are supplied, and are supplemented by about 500 ceiling and cabin fans.

THE MAIN ENGINE-ROOM.

We reproduce on page 244 a series of photographs of the main engine-room, one view alone, the last one, being taken in the auxiliary engine-room. It is hardly necessary to describe the main engines in detail, as this we have already done for an engine of the same type in our issue of February 27th, 1925, and again for the Swedish liner the Gripsholm in THE ENGINEER of December 4th last. Some small differences in design or construction may, however, from time to time be mentioned in the course of our description. The two main motors are placed a little aft of amidships, and they consist of two eight-cylinder four-cycle double-acting Harland-B. and W. type marine oil engines. At the forward end of each engine there are twin air compressors, driven from the main crank shaft, which serve to provide the blast injection air. Each main cylinder has a bore of 840 mm. and a stroke of 1500 mm., and the two units are designed for a normal output of 20,000 indicated or 15,000 brake horse-power, when running at a speed of about 115 revolutions per minute. Drawing Fig. 2, which corresponds to a section through the port engine looking aft, will serve to indicate

the chief points in the engine design. The bottom combustion space is slightly offset from the cylinder, and the valves, with the exception of the vertical exhaust valve, are placed obliquely, as shown. At the top of the engine the valve gear accords with that of the single-acting type of engine ; indeed, as regards most points in the construction the two designs are not dissimilar. Both the top and the bottom levers are operated by push-rods, worked from the cam shaft at mid-cylinder level.

The view, Fig. 7—see page 244—shows the engines as seen when entering the engine-room from the working alleyway. The spring supported exhaust pipes will be noted at the forward end of the engine-room, where they are carried up to join the two silencers in the engine hatch and afterward discharge into the aft funnel. The air inlet trunks, with intakes at either end, are neatly stowed at the sides of the engine-room, just above the cylinder tops. The top platform is common to both engines, with a grating between and ample room is thereby given for removing valves and overhauling generally. For assisting in this work each engine is served by two 10-ton electric cranes, mounted on overhead runways, and controlled from the centre of the top platform. Hand cranes are also fitted for lifting out the valves. In addition to the main platform between the engine, small platforms are provided at intervals between the cylinders, so that the valve gear can be overlooked with ease ; it is also possible to walk round the engine without difficulty. In passing, we may remark on the oiling system adopted for the valve levers and rods, which consists in supplying oil under slight gravity pressure to the centres of the fulcrum spindles. Close-fitting pipes carry the oil to the push-rod joints, after which it serves to lubricate the cam rollers. Thus little attention to oiling is required at top platform level.

The upper middle platform—shown in Fig. 8—gives access to the cam shaft and the two manœuvring shafts, which lift the rollers from the cams when reversing is taking place. We noted that the general lighting of the intermediate platforms was very good. At the lower intermediate platform—see Fig. 9—access is given to the bottom valve gear, and at the end of the engine to the air compressor valves. Siemens pyrometers are fitted, so that exhaust temperatures, both top and bottom, can quickly be determined and checked. Illustration Fig. 10 is a view looking aft in the starboard engine-room wing ; it shows the level of the bottom platform and the sunk platform of the engine-room wings, which is about 3ft. lower. In this view the manœuvring air receivers and some of the lubricating oil filters will be seen. The clear space at the control station between the main engines at bottom platform level is well illustrated by Fig. 11. It shows both starting controls as seen when looking forward. Immediately in front of the operator are the two quadrant levers which control the admission of starting air and fuel to the top and the bottom sides of the cylinders respectively, and to the right is the reversing lever for operating the servo motor, which brings the ahead or astern cams into position as required. An automatic ahead and astern indicator is also fitted. To the left of the operator are the various controls for manœuvring air, blast air, &c., with suitable cross connections between the engines ; further left is the gauge board, with all the necessary pressure gauges. The blast receivers, of which there are three to a unit, are grouped at the forward end of the bottom platform. At the after end of each engine a small fly-wheel is fitted ; it engages by means of worm gearing with the 25 brake horse-power, 220-volt turning motor. A thrust bearing of the Michel type is fitted between the fly-wheel and the propeller shaft.

We were interested to note that a Ford torsion-meter, made by Siemens Brothers, has been fitted in the ship. In the space forward of the main engines there are situated the lubricating oil pumps, an emergency steam-driven air compressor, and salt water circulating pumps, by W. H. Allen, Sons and Co., Ltd., for the air compressor and exhaust jackets. The cooling water for the main cylinder jackets is fresh water, and special circulating pumps with coolers are provided. There are also lubricating oil coolers, pumps and filters for piston cooling and lubricator oil service, which are placed in the wing spaces. At each side of the engine-room there are two manœuvring air compressors, driven by 180 brake horse-power motors at 250 revolutions per minute. The manœuvring air is stored at 25 atmospheres pressure in six steel cylinders, about 6ft. 6in. in diameter, with a length of 23ft. 6in., which are grouped three units in the port and starboard wings respectively. One group of these receivers is illustrated in Fig. 10. Other pumps include a Drysdale Centrex bilge pump, circulating pumps, and the oil fuel transfer pumps. Firefoam apparatus is installed in the engine-room. We were generally impressed by the spaciousness of the engine room and its arrangement. Although there appeared to be ample ventilation, additional suction fans are fitted in the engine hatch in order to remove any trace of oil vapour. The running of the main engines appeared to be very satisfactory and free from vibration, which is perhaps contributed to by the careful balancing, the arrangement of the order of firing, which, we understand, is based on the principle of placing consecutively firing cylinders as remote from one another as possible, so as to avoid local elastic strain in any part of the crank shaft, and the stiff cross bracing of the two sets of motors, both at the centre and the ends of the engines.

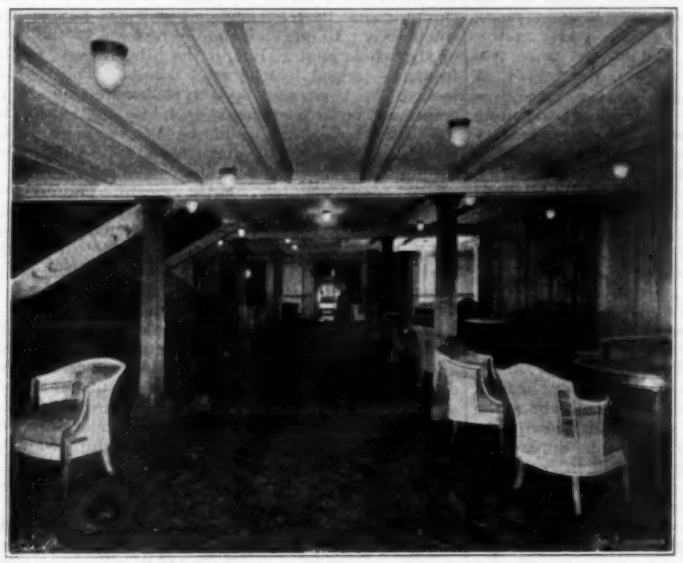


FIG. 3—FIRST-CLASS ENTRANCE ON B DECK

FIG. 4—FIRST-CLASS DINING SALOON

FIG. 5—FIRST-CLASS SMOKING ROOM

FIG. 6—THE WINTER GARDEN

THE AUXILIARY ENGINE-ROOM.

Forward of the main engine-room is the auxiliary engine-room, in which four four-cylinder Harland-B. and W. generating units, each designed to give a normal output of 400 kilowatts at 220 volts, when running at the moderate speed of 165 revolutions per minute, are placed. Fig. 12 is a view at the forward end of this engine-room taken over the generators. At this end of the room is a long switchboard gallery with the sixteen panels which serve the lighting and power circuits of the ship. This board is also interconnected with the emergency

generator switchboard at top deck level. At the after end of the auxiliary engine-room are arranged two heating boilers, of the Cochrane oil-fired type, designed for a working pressure of 100 lb. per square inch, and fitted with Clyde oil-fuel burning apparatus. At this end of the engine-room is also an engineers' workshop, with a lathe and drilling machine. At the top platform level various stores are arranged, leading off the engine-room. The machinery in the auxiliary engine-room wings includes the oil pumps and heaters for the boilers, circulating water and automatic ball-float operated fresh-water pumps, which serve the Buhrings filters and clarifiers in the tank house on the top deck. In this room an S O S emergency bilge pump of 180 tons per hour, by Drysdale, is also fitted. There are also lubricating oil pumps for the generator engines, and centrifugal oil cleaners of the De Laval type. Centrifugal cleaners of the Sharples type are employed for the fuel oil. An interesting group of machinery in the port wing is the pumping equipment, accumulators, &c., for the hydraulic cranes on deck. The pumps and accumulator were built by Fullerton, Hodgart and Barclay, Ltd., of Paisley, and the Ward-Leonard electric controls were supplied by Laurence Scott and Co., Ltd., of Norwich, which firm also built several of the pump and crane motors aboard the ship. We hope to refer to the hydraulic cranes and control gear in a later article. The refrigerating machinery is arranged in a special compartment forward of the auxiliary engine-room. It was supplied by J. and E. Hall and Co., Ltd., of Dartford, and is electrically operated by Laurence Scott variable-speed motors, which give considerable flexibility to the plant. The circulating pumps, brine pumps and brine booster pumps were made by Drysdale and Co., Ltd., of Yoker, Glasgow.

The Asturias carries in all nineteen engineers. There are senior and junior Chief, second, third and fourth engineers, three fifth engineers and five sixth engineers, besides two electricians and a refrigerating engineer.

In the course of this short description we have only recorded some of our impressions of the ship and her machinery. There is no doubt that the Asturias will mark a new era in large motor-propelled liners. Her sister ship the Alcantara is expected to be completed during the course of the year.

Agricultural Machinery Exhibition at Brussels.

By our Special Representative on the Continent.

THE thirteenth annual exhibition of Agricultural Machinery, organised by the "Société de Mécanique et d'Industries Agricoles," was opened at the Palais du Cinquantenaire, in Brussels, on February 20th. The scope of the Exhibition may be indicated by comparing it to a combination of the machinery and implement sections of the R.A.S.E. and the Smithfield Shows in England, held in a building with a remarkable resemblance to a glorified Olympia—galleries, annexe and all. One missed the turf and the sky and the open air which are such pleasant features of the English Royal Show, but the hum of thrashing machines and the sight of steam and oil engines in motion did much to obviate the kind of cold-storage atmosphere which pervades the machinery at Smithfield. The Brussels Show was organised under the patronage of the Belgian Minister of Agriculture. Admission cost only two francs, or 4½d. in English money, for those who had not got tickets; soldiers and members of Agricultural Societies were admitted at half price, and school parties could enter free. A catalogue of 270 pages was sold at one franc, with every exhibit listed in both French and Flemish, in accordance with the bilingual custom for all official publications in Belgium. The Hall, with its galleries and annexe, contains 170 different stands, generally of large dimensions, and well filled with machinery, and the Exhibition, on the whole, had an air of serious business. There were no refreshment bars, and smoking was forbidden, which seemed curious when steam and oil and petrol engines were allowed to be operated, and stoves were in service here and there. The floor certainly was not combustible, as it was formed of loose grit and sand, which looked more pleasant than it felt to walk on.

Belgium is essentially a country of small farms, and this feature was reflected in the agricultural machinery. The horse can well hold its own against the agricultural tractor, though the latter finds its uses, and many of the well-known types were exhibited, the Austin being the only one we noticed, of English design. It may be significant of a change in agricultural conditions that several of the portable machines, such as thrashers, were fitted with electric motors for three-phase current at about 220 volts. Some of the milk-separators were also motor driven. In one particularly neat arrangement the motor was of ½ brake horse-power, running at 2800 revolutions per minute; it was totally enclosed, and merely formed a cylindrical projection from the side of the machine, about the size of a pint pot. Current was supplied from a 220-volt circuit by means of a plug and flexible connection. The motor not only drove the separator, but a slow speed shaft on the latter was connected to the spindle of a barrel-churn about 6ft. away by a telescopic shaft and a flexible clutch of the simplest possible description, so that the churn was driven as well as the separator. The development of electrical driving for farm machinery was also indicated by the exhibition of electric motors by no less than fourteen different firms. The Etablissements R. A. Lister, whose works are at Landen, showed electric motors ranging from 1·5 horse-power to 6 horse-power, all for three-phase 220-volt current. The 2 and 3 horse-power sizes were plain slip-ring motors, and above this size short-circuiting devices were fitted. Messrs. Lister were also among the twenty-two firms showing petrol motors, these apparently being a production of their Dursley Works. The vertical totally enclosed petrol motor seemed to have found much more favour than the horizontal hopper-type design, but the latter still had its supporters, possibly on account of price. The Usines Deville et Cie., of Charleville, France, were prominent amongst the exhibitors of vertical petrol motors. Their list price for a 1½ horse-power motor at 500 revolutions, weighing 265 lb., was 2750 Belgian francs, free on rail at Brussels. For a 4 horse-power motor, at 410 revolutions, weighing 720 lb., the price was 4125 francs; while for an 8 horse-power motor, at 350 revolutions, weighing 1320 lb., the price was 5800 francs. The powers given are the maximum ratings, and the prices include everything necessary for the motors to be put to work. For an extra 720 francs the motors would be supplie on a hand-carriage, and for another 80 francs the carriage would be fitted with shafts. The company has realised the requirements of an agricultural market by keeping a dozen motors of each size at Brussels ready for instant dispatch, and also carrying a complete stock of spare parts in the same city.

The Belgian ploughs struck one as lighter than the English ploughs, and a very common type was a single-furrow plough adapted for ploughing either a right or left-handed furrow. The skim-coulter, knife-coulter, share and mould-board were all duplicated, and either set could be rotated as a unit about the backbone of the implement, and swung down into action as desired. The change-over is apparently made at the head-lands to suit the Belgian system of ploughing, which seems to an outsider a tedious way, though one does not care to criticise a system which has doubtless been evolved to suit local conditions.

Like British makers of agricultural implements, the Belgian manufacturers seem to compete with one another with regard to brilliance of colour effects. Both seem, however, to agree that a light blue is the best general colour for a plough and also for a cake-crusher, but the continental maker has found ways of obtaining even more fearful contrasts with reds and yellows than one usually meets in England. Moreover, this riot of colour has partially extended to thrashing machines, which do not in England usually appear painted otherwise than in a modest sort of pink. Nobody yet seems to have found a reason why agricultural machines should be so violently coloured. It seems to be a universal tradition that they must be so, and the custom of gaudy colouration is much too old to be due to any post-war movement to get "brighter agriculture."

The grass-cutting, hay-tedding and reaping machines differed little, if at all, from those familiar in England, the designs of such machines being almost as international as their sales. Among British makers one noticed the names of Ruston-Hornsby and Harrison, McGregor, while a Clayton thrashing machine and a Bamford hay-loader were also in evidence. Such British machinery as there was in the Exhibition was always on the stand of an agent, no firm exhibiting directly. Among the minor machines of continental design a hand-operated grindstone struck one as curious. The stone was driven by bevel wheels so that the crank handle rotated in a plane across one end of the machine. The bevel gearing certainly gave about a 50 per cent. increase in speed, but whether it was adopted in preference to spur gear for mechanical reasons, or whether the position of the crank handle was supposed to make it possible for a man to turn the stone with one hand and hold the work with the other was not clear. One of the most interesting machines at the Exhibition was a flax puller on the stand of Messrs. Sabbe et Claix, of Winckel St. Eloy. As the machine goes along a series of long fingers, a few inches apart, are continually thrust sideways into the standing crop, and guide the stems to a place where they are pinched between rubber bands and so pulled out of the ground. To pull flax by machinery without injuring the crop or leaving a lot of it standing is an extremely difficult problem, and possibly an insoluble one under all conditions of crop and soil, but the machine in question deserves success, if only for the mechanical ingenuity displayed in the design. One often finds ingenuity of a high order displayed in connection with agricultural machinery, the self-binder, swath turner, hay tedder and potato digger all being examples of it. Another novel machine was one for lifting beetroots on the stand of Landrain Frères, of Fexhe-le-Haut-Clocher. As the machine is pulled along two rows of the roots are lifted out of the ground simultaneously by pairs of inclined shafts, which pass between the rows. The roots are brought by the forward motion of the machine on to a sort of inclined table formed of four transverse rows of spiked wheels, which are driven at high speed by chains and gearing from the road wheels. Being violently tumbled about by going up this inclined table, the dirt is knocked off and can fall freely through the table. The roots are fed by the motion off the table to a small cross conveyor at the end, which delivers them in a row at the side as the machine goes along.

The greatest contrast with British practice as regards machinery was noticeable in the case of portable steam engines. There were as many as six of these at the Exhibition, which may not seem a lot to those familiar with agricultural exhibitions of twenty years ago, but it is more than have been seen together at the R.A.S.E. Show for several years, so universal has the oil engine become as a prime mover. In not one instance did any of the Brussels engines resemble British practice. In two of the engines which were built by French firms the fire-box was cylindrical, and was contained in a cylindrical casing like a sort of vertical boiler, from the side of which the main boiler barrel extended. Ordinary fire-tubes through this barrel connected the fire-box to the smoke-box. In one case the fire-box was at the back of the whole engine, but in the other it was at the front, as judged by the road wheels. The engines looked like horizontal open type land engines, self-contained on a continuous bedplate bolted to the top of the boiler. Flat slide bars at the sides of the crosshead were used, and the crank webs were machined square. The Belgian engines, all four of which were running under steam, had boilers consisting of a horizontal shell containing a flue and furnace like a Cornish boiler. This flue, however, did not go right through, but terminated in a combustion chamber, from the top and sides of which return tubes led the gases back to the smoke-box around the front of the furnace. By undoing a circumferential bolted joint behind the smoke-box the whole of the furnace, flue, combustion chamber and return tubes could be withdrawn together for cleaning and inspection. As in the case of the French portables, those of Belgian make seemed to favour self-contained engines bolted to the boiler top, but bored guides were used. The workmanship of all the portable engines seemed thoroughly good, and the use of cut cranks, polished all over, showed that even an unnecessary amount of work was not objected to. All the engines were comparatively small, probably about 14 to 16 brake horse-power. The usual steam pressure was 10 kilos., or about 140 lb. per square inch.

The Exhibition, which closes on February 28th, was very well worth a visit by everyone interested in agricultural machinery, for so large and well arranged a collection of farming implements and apparatus is rarely brought together, or can be seen under such advantageous circumstances.

DRIVING A CABLE TUNNEL UNDER THE THAMES.

AT a meeting of its Association of London Students, held at the Institution of Civil Engineers on Wednesday, February 17th, at six o'clock p.m., Mr. David Anderson, M. Inst. C.E., in the chair, Mr. D. S. Matheson read a paper on "Subaqueous Tunnelling in Compressed Air with reference to the Barking Power Station Cable Tunnel under the River Thames."

The author described how the 7ft. internal diameter tunnel was constructed for the County of London Electric Supply Company, Ltd., and stated that it is to be used for conveying electric cables from the recently completed power station to the south bank of the river Thames. It was found, he explained, that unless this tunnel were built, a detour of several miles would be necessary in order to carry the cable across the river. A description was given of the preliminary work which had to be carried out before the preparation of the working drawings. It consisted of the determination of the geological strata by trial borings, the taking of soundings of the river bed directly above the line of the tunnel, the establishment of a bench mark at the south shaft directly across the river from a fixed bench mark at the north shaft, and triangulation to determine the actual distance across the river. The trial borings disclosed the fact that the ground to within 6ft. or 7ft. of the surface was water bearing, and also that the tunnel would be entirely in chalk, the axis being approximately at a level 95ft. below ground level at the shafts. Almost full static head was encountered, which necessitated a pressure of 35 lb. per square inch gauge to keep the workings dry.

The shafts and first lengths of tunnel were constructed in free air. Both shafts were sunk at the same time and tunnelling was commenced simultaneously from both shafts. In the north shaft the volume of water coming in during the work in free air made it impossible for the work to be carried out expeditiously. In an endeavour to allow of the sinking of the shaft and a length of tunnel sufficiently long to accommodate the air lock being completed it was decided to cementate the surrounding ground by pumping cement grout in under high pressure.

During the working in compressed air a complete record was kept of the number of cases of illness, and the author gave some interesting statistics in connection with caisson disease, it being found that the percentage of illness was greatest amongst those unaccustomed to high pressures.

A PIECE of Major A. M. Taylor's 150,000-volt cable, which has been tested up to 725,000 volts, is being exhibited at the British Industries Fair.

Railway Matters.

THE morning boat train for the Dover–Ostend route now leaves Victoria at 9.15 instead of 8.50. The time of arrival at Ostend remains as before; the 25 minutes' gain is all saved in the running between London and Dover.

THE railway statistics for November of the Ministry of Transport have recently been published by the Stationery Office, price 3s. They show that, compared with November, 1924, the number of passenger journeys decreased by 1·3 per cent., and the passenger receipts by 5·2 per cent. Despite these reductions the passenger train mileage increased by 2·8 per cent. The freight traffic had a decrease of 2·9 per cent., and the ton-miles one of 2·3 per cent. On the other hand, though, there was an increase of 0·7 per cent. in the freight receipts and a decrease of 1·9 per cent. in the freight train mileage. The average train load fell from 133 to 132 tons, and the net ton-miles per engine hour from 433 to 414¼.

IT is expected that the new tube link between the Piccadilly and City lines at King's Cross will be completed during the present year. The rolling stock of the latter line will then be able to reach the tracks of the former, and thus gain the company's overhaul depôt at Acton. This work is at present done at Golder's Green, and some relief is necessary there owing to the additional strain which will be thrown upon it when the Kennington and Morden extensions are opened. A step plate junction has now been constructed at the point where the new loop joins the City Railway, and preparations for the sinking of a working shaft are being made at Midland-road, King's Cross. It is expected that the actual driving of the tunnels will begin in a few weeks' time.

WORKS are in hand to enable the Central London tube, now dependent upon the Wood-lane power station for most of its current supply, to be supplied entirely from the power house at Lots-road, Chelsea. The existing steam plant at Wood-lane, which dates mainly from 1900, is now obsolete and inefficient, compared with present-day standards. Cables from the Lots-road station have already been laid, and in view of the different voltage of high-tension supply on the Central London Railway, a transforming station is being installed in the Wood-lane power house, which will thus become a distributing centre for the railway. Additional plant also is being installed at Lots-road to provide for the further demand which will be made upon its output by the Central London Railway and other increased services and extensions.

WHERE a railway company has a much longer route—technically called a circuitous route—than another company, the former may charge a lower rate. As that has been thought to lead to uneconomical working and wasteful competition, the Railways Act, 1921, ordered that the rates for the longer route be the same as for the shorter, unless otherwise determined by the Railway Rates Tribunal. A circuitous route was specified as one longer by 30 per cent. or more. The subject came recently before that body, when counsel for the railways said that the companies had investigated 340,669 routes, and had scheduled 48,667. Of the latter number, 19,868 were 50 per cent. or more in excess of the shortest. The London and North-Eastern had 36,687, in distinct contrast to 5228 on the London, Midland and Scottish. The preparation of the schedule had cost £12,000.

THE report of Major Hall on the collision of September 15th last at Victoria Station, Sheffield, has recently been issued. In that case a passenger train from Cleethorpes for Manchester stood in the station and was run into by a passenger train from York. The driver of the latter train found the outer home at "clear," and then the inner home signal, 80 yards further on, also at "clear." The weather conditions that afternoon were exceptionally bad and prevented the signalman from seeing the approach of the second train, and he lowered his signals when he thought the train was near them. With the station already occupied, the second train should have been stopped and admitted under a green flag. The driver was, however, misled by the signals being "off," and he took the green flag as a matter of usual practice. The climatic conditions already referred to prevented his seeing the other train and the collision—a slight one—resulted. Major Hall recommends the provision of a calling-on arm, as such would be "the conveyance to a driver, by the use of a special and distinctive signal, of a definite warning that the road is occupied between one signal and the next."

THE Board of Trade exports tables for December give, of course, the total business done during the year. The figures as to the railway material exported during 1925 are as follows, the corresponding figures for 1924 and 1923 being added in brackets:—Locomotives, £2,558,887 (£1,851,537, £2,893,626); rails, £1,896,960 (£1,624,211, £2,560,766); carriages, £1,619,601 (£1,195,963, £987,014); wagons, £3,671,191 (£3,247,203, £3,167,374); wheels and axles, £599,540 (£547,294, £984,449); tires and axles, £439,775 (£605,524, £697,676); chairs and metal sleepers, £1,023,332 (£1,142,687, £950,552); miscellaneous permanent way material, £1,439,858 (£1,166,328, £1,305,375); total permanent way material, £5,604,327 (£5,306,457, £6,807,256). The weight of the rails exported was 207,615 tons (174,711 tons, 287,534 tons), and of the chairs and metal sleepers 94,126 tons (91,160 tons, 82,404 tons). Thus in every item, except those for tires and axles and for chairs and metal sleepers, there was an increase over 1924. During the month of December alone the value of the locomotives exported was £210,457, of which the following countries received the amounts indicated:—South America, exclusive of the Argentine, £79,680; India, £31,156; Ceylon, £17,910; Australia, £14,635; Argentine, £8239; certain unnamed "other countries," £55,688. The rail exports for December alone were £185,458, of which the principal items were South Africa, £68,738; Argentine, £41,364; Straits Settlements, £24,276; India, £17,638; New Zealand, £4122; Australia, £1641; certain other countries, £24,820. During the year 1925 India was our best customer for locomotives and the Argentine the worst; the former had to the value of £945,053, and the latter £428,941. The Argentine had the largest, with £432,573, for rails; the next best being £208,722 for South Africa, and £202,984 for New Zealand.

Notes and Memoranda.

IN commenting on the likelihood of inland waterways taking a more important part in the transport facilities of the United States, the *Engineering News-Record* points out that the development of motor vehicles may help the canals, through extending the area tapped by the latter; but it is suggested that the improvement of terminal facilities is of paramount importance.

SLATE for structural and sanitary purposes, notwithstanding its satisfactory qualities, has not been used in many instances because its natural dark colour does not harmonise with the designs or colour effects desired. To overcome this difficulty an American firm has recently developed a finishing process by which structural slate is surfaced in white, light, or such colours as conform to any required condition.

IN the construction of the flexible pipe line across the upper end of San Francisco Bay a structural steel cradle with untreated timber framing, pipe guides, &c., was used. It was submerged in the bay waters for a period of about three months. When the work was completed and the cradle was lifted from the water the timber portions were found to be so riddled by the boring of teredos that they fell apart under their own weight.

IT is claimed by the International General Electric Company that the two 45,000-kilowatt turbo-generators, which were recently started up at Columbia Park, Ohio, work at the highest steam pressure in commercial use in the United States. Steam is supplied to the turbines at a pressure of 600 lb. per square inch and a temperature of 725 deg. It leaves the high-pressure machine at 425 deg. and is re-heated to 725 deg. again. The final temperature is about 80 deg. Pulverised coal and air preheating have been adopted.

A BOOKLET entitled "The National Significance of Electricity" has just been issued by the British Electrical and Allied Manufacturers Association, the publishers being the Electrical Publicity Bureau, of 180, Fleet-street, E.C. 4. It deals with the electrical engineering and supply industries, the national development of electricity supply, the proposals of the Government for greater national electrification, and the industrial significance of standardisation, the articles having been reprinted from the *Financial Times* and the *Economist*.

ENGINEERS and power users, states Dr. T. B. Morley, in a paper on "Uniflow and Extraction Steam Engines," have in the past been so much obsessed with the idea of obtaining the lowest possible steam consumption rate per horse-power hour in the steam engines with which they have had to deal, that they have too seldom considered the needs of industrial factories as a whole. The result is that in many factories where steam is required for process purposes, no attempt has been made to link up the power production with the production of the process steam. It has not been sufficiently realised that steam required for process work is capable of replacing part of the steam used separately for power production, and that the ideal to aim at is that as far as possible all the steam necessary for heating purposes should have, in the first place, been utilised for power production before passing into the heating mains.

IN an article on "Ward Leonard Control of Winding Engines," appearing in the January issue of the *Metropolitan Vickers Gazette*, Mr. E. Le Law Lamb states that for ease and delicacy of control the Ward Leonard system is superior to the straight alternating-current system, and for winders of more than, say, 1000 horse-power it is undoubtedly the best. It is also superior if equalisation be required. In the majority of cases the consumption of electrical energy is much lower and in many cases the cost of maintenance is less. Against these advantages must be set the higher capital cost—a Ward Leonard winder may be taken to cost approximately 1·8 times as much as an equivalent alternating-current equipment—and apart from the question of equalisation the decision as to which system to employ is generally made by comparing the interest on the extra capital with the saving in power consumption.

CONSIDERABLE difference of opinion exists concerning the conditions in which the superiority of garnet paper over quartz sandpaper is most marked. For many kinds of work it is universally conceded that the use of garnet paper is more economical than quartz or sandpaper, although its initial cost is greater. In abrading soft, resinous woods garnet and sandpapers appear to be nearly equal in efficiency, as both are soon clogged with the abraded particles of wood and the cutting edges so blinded that the paper must be discarded. In working hardwoods and similar substances the superiority of garnet over quartz becomes most pronounced. Reports concerning the effectiveness of garnet on hardwoods vary with local conditions, but indicate that garnet will cut from two to six times as much wood as quartz, whether measured by weight or the area of the surface abraded. Garnet does not have enough hardness to abrade the harder metals, but can be used satisfactorily on many of the softer ones, including copper, brass, and bronze. Garnet cuts leather rapidly and evenly.

THE scheme for the improvement of Canton Harbour, which is estimated to cost approximately one million sterling, includes the following works:—(1) The construction of four wooden quays, each to be 30ft. wide and between 200ft. and 300ft. long, estimated at a total cost of 110,000 dollars; (2) the provision of warehouse facilities by building eight godowns, each to be 100ft. by 60ft. and 30ft. high, estimated at a total cost of 120,000 dollars; (3) the building of a concrete pier 1200ft. long, estimated at 140,000 dollars; (4) the dredging of the harbour near the pier to a depth of 30ft., estimated at 20,000 dollars; (5) the raising of the water front near the pier to a certain level above the high-water mark with the dredged silt from the harbour, estimated at 15,000 dollars; (6) the building of a light railway 2½ miles long, from the quays to the Canton-Samshui railway station, to facilitate the handling of merchandise, estimated at 120,000 dollars; (7) the acquiring of certain private land for such constructive works, estimated at 20,000 dollars; (8) purchase of dredging apparatus, estimated at 100,000 dollars.

Miscellanea.

THE output of coal from the mines of Great Britain for the week which ended on February 13th was 5,398,800 tons, as compared with 5,340,700 tons for the corresponding week of last year.

THE Home Secretary has appointed Major T. H. Crozier to be Chief Inspector of Explosives, in succession to Sir Aston Cooper Key, C.B., retired, and Colonel R. A. Thomas, C.B.E., to be Second Inspector of Explosives in place of Major Crozier.

A PAMPHLET, entitled "A Word in Favour of the Independent Power Plant," has been issued by W. C. Mountain, Son and Wood, of Sun Buildings, Newcastle-on-Tyne. It has been written by Mr. Mountain, who puts forward a great many arguments in favour of small power plant.

IN pursuance of the policy of carrying out the work of survey, which is one of the main aspects of the fuel research work of the Department of Scientific and Industrial Research, a committee has been appointed to deal with the physical and chemical survey of the coalfields of Nottinghamshire and Derbyshire.

IN order to assist passengers who are unaccustomed to underground travel, the Underground Railway Company is said to be contemplating the use of loud-speakers at some of the principal stations. It is believed that much of the delay caused by the inspection of signposts might be avoided in this way, as one man could direct passengers to their proper routes on the "public address" system.

AN account of the expenditure in respect of the London Post Office tube railway was issued as a White Paper on Tuesday, February 16th. It is shown that the total expended to March 31st last was £1,100,000, which is the full amount authorised. The heaviest item is tunnelling costs, which aggregate £780,007, while permanent way, &c., involves £165,381. Preliminary expenses and professional fees are returned at £44,512.

SPEAKING in London recently on the smoke evil, Dr. John S. Owens stated that the cost arising either directly or indirectly from smoke approximated in the case of London to 24s. per head per annum, in Manchester 30s. per head, and in Pittsburg to 87s. per head. The cost to the whole country was colossal. All this was preventable, and the engineer was quite capable of dealing with the problem if only there was a strong public demand for a solution.

THE Permanent International Association of Road Congresses will hold its this year's gathering in Milan in September. The following have been appointed by the delegates of Great Britain to report on concrete roads:—Mr. W. S. Richmond, A.M. Inst. C.E., Divisional Road Engineer, Ministry of Transport; Mr. A. Harrison, M. Inst. C.E., borough engineer and surveyor of Southwark, London; Mr. J. B. L. Meek, M. Inst. C.E., city engineer, Manchester; and Mr. W. P. Robinson, county surveyor, Surrey County Council.

IT is announced by the Royal National Lifeboat Institution that, on account of the growing importance of the motor lifeboat and the fact that there are now nearly sixty motor lifeboats in commission, it has decided to appoint Engineer-Commander A. G. Bremner, R.N., to take charge of the machinery of the fleet. Commander Bremner, who joined the Navy in 1900, has had a long and varied experience with marine oil engines. Prior to the war he was the resident Admiralty overseer, first at the Turin Works of the F.I.A.T. Company, and later at Sulzer Brothers, Winterthur. He collaborated with Mr. James Richardson in the translation from the Italian of Ing. G. Supino's book on land and marine Diesel engines.

WHEN Sir Henry Maybury returned from his tour last autumn of some of the cities in the United States, he said, in an interview, that he was much impressed with the use of light signals, like those found on railways, for controlling road traffic. It is now announced that such signals are to be fixed at the junctions with Piccadilly of each of the six streets that lie between Berkeley and Old Bond streets inclusive, and that there is to be in Piccadilly itself one signal at each end of that area. Near the top of St. James'-street a control officer will be stationed, who will change the colours in the signals to stop the traffic or allow it to flow, as he considers necessary. The signals have three lights—red, yellow and green—but only one can be illuminated at the same time. When red is shown the traffic must stop; when green is exhibited it may move. As an intimation that the green signal is about to be given and to prepare drivers to be ready to move, the red light is first changed to yellow for a few moments. Similarly, when green is being shown and traffic is about to be stopped, yellow is first exhibited before the red light is given.

IN the House of Commons recently Sir William Mitchell-Thomson (Postmaster-General), in reply to Sir H. Brittain, said that there was at present no two-way communication by Government wireless between this country and the Dominions, though it was hoped to open such a service during the current year with Canada, South Africa, India and Australia by means of the beam stations, now under construction here and in those countries. The contractors hoped to complete the respective stations here and in Canada and South Africa in April, and those for the Indian and Australian services in August. With regard to one-way communication, there had for some years been a regular Press service from Leafield to Halifax, Nova Scotia, and the opening of the Rugby station had now made it possible to broadcast messages for reception in any part of the Empire. At present official news messages were sent out from Rugby thrice daily, and good reception of them was reported from places as far distant as New Zealand. In addition, private messages for ships anywhere in the world were now regularly transmitted from Rugby, and reception appeared to be satisfactory, though it was as yet rather early to be quite definite on the point. Sir H. Brittain asked if any progress had been made in wireless telephone communication between this country and Canada. Sir W. Mitchell-Thomson replied that experiments were continually going on, but it was too early as yet to say whether any substantial progress had been made.

THE ENGINES OF THE R.M.S.P. MOTOR LINER ASTURIAS

HARLAND AND WOLFF, LTD., BELFAST, ENGINEERS

(*For description see page 240*)

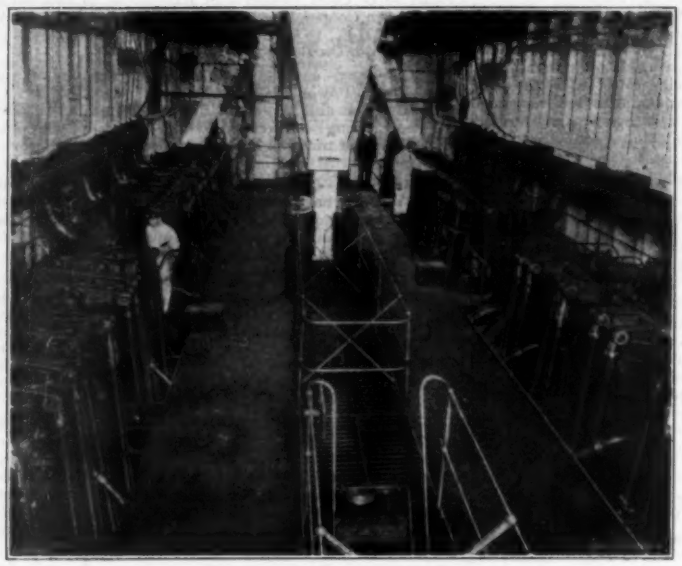


FIG. 7—TOP PLATFORM LOOKING FORWARD

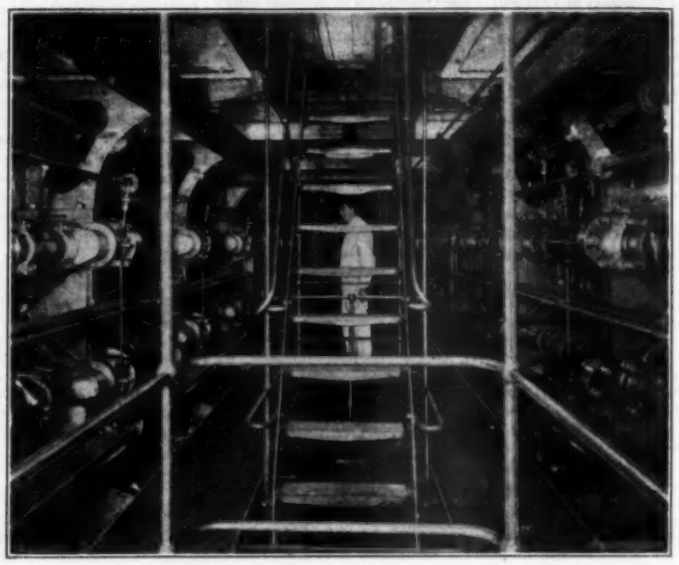


FIG. 8—UPPER MIDDLE PLATFORM SHOWING REVERSING SHAFTS

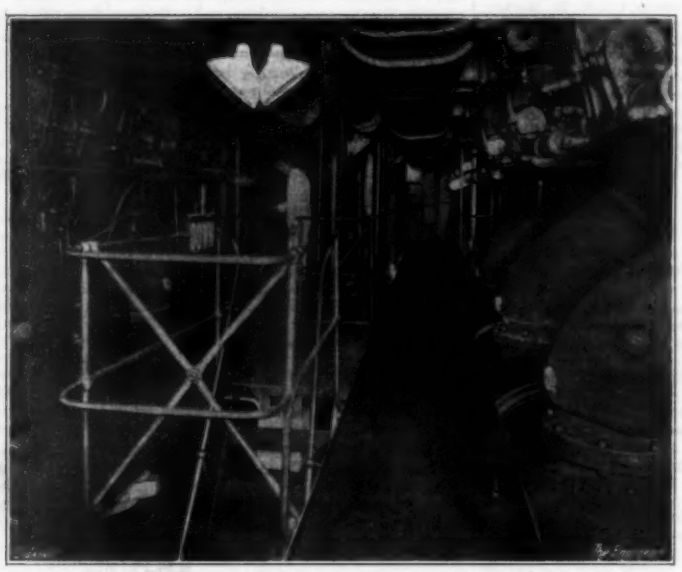


FIG. 9—BOTTOM VALVE GEAR AT LOWER MIDDLE PLATFORM

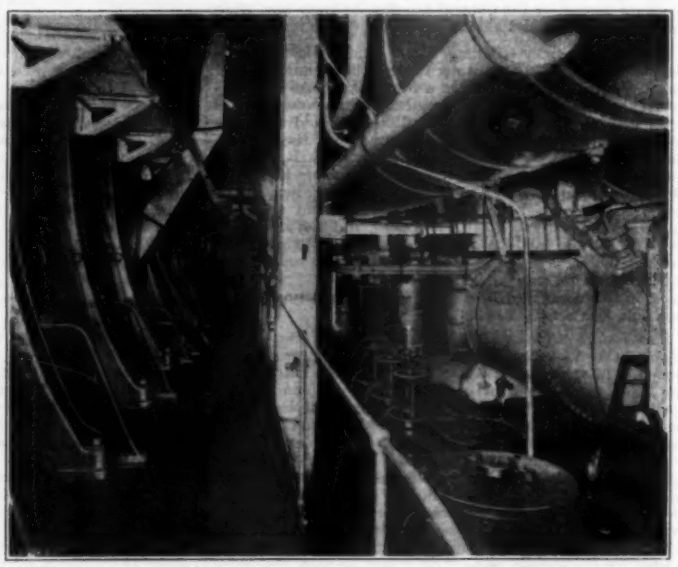


FIG. 10—VIEW IN STARBOARD WING, LOOKING AFT

FIG. 11—BOTTOM PLATFORM SHOWING ENGINE CONTROLS

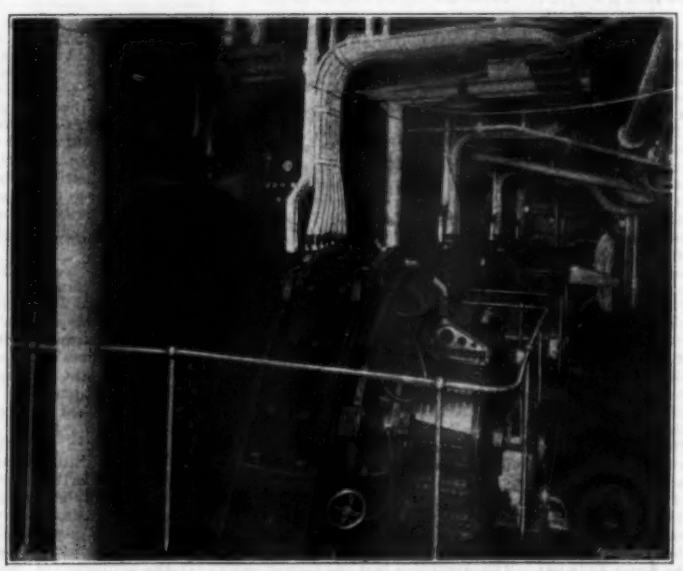


FIG. 12—MAIN GENERATORS IN AUXILIARY ENGINE-ROOM

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—MITCHELL'S BOOK STORE, 576, Cangallo.
CHINA.—KELLY AND WALSH, Limited, Shanghai and Hong Kong.
EGYPT.—CAIRO EXPRESS AGENCY, near Shepheard's Hotel, Cairo.
FRANCE.—BOYVEAU AND CHEVILLET, Rue de la Banque, Paris.
CRAPELOT AND CIE., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. SMITH AND SON, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. COMBRIDGE AND CO., Bombay; THACKER AND Co., Limited, Bombay; THACKER, SPINK AND CO., Calcutta.
ITALY.—MAGLIONI AND STRINI, 307, Corso, Rome; FRATELLI TREVES, Corso Umberto 1, 174, Rome; FRATELLI BOCCA, Rome; ULRICO HOEPLI, Milan.
JAPAN.—MARUZEN CO., Tokyo and Yokohama.
AFRICA.—WM. DAWSON AND SONS, Limited, 7, Sea-street (Box 49), Capetown.
C. JUTA AND CO., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—GORDON AND GOTCH, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
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SIXTEEN-PAGE SUPPLEMENT.—THE METALLURGIST.

The Metallurgist

THE FEBRUARY NUMBER OF THE MONTHLY METALLURGICAL SUPPLEMENT TO "THE ENGINEER" ACCOMPANIES THIS ISSUE.

THE ENGINEER.

FEBRUARY 26, 1926.

Cutting Temperatures.

IT is to be feared that the significance of some of the results of Mr. E. G. Herbert's investigations on cutting temperatures may be overlooked or misunderstood as a consequence of the slightly irregular manner in which they have been presented. Possible foreign anticipation of the subject led to the publication of Mr. Herbert's paper some two months ago as a supplement to the *Journal* of the Institution of Mechanical Engineers. Subsequently to its publication certain important new observations and deductions were made, with the result that the summary of the paper as presented by Mr. Herbert before the Institution in Manchester on February 4th and in London last Friday embodied a considerable amount of matter that was not to be found in the paper as printed and circulated to the members. Mr. Herbert had some very interesting new remarks to make on the so-called "Whitaker ring" and the relationship between the "free cutting range" of metals and their work-hardening capacity, which it led him to deduce. He illustrated his remarks by a series of lantern slides, the originals of which we are enabled to reproduce elsewhere in this issue. We are of opinion that had the diagrams shown as slides been embodied in the paper and not passed in succession across the screen in a manner virtually prohibiting comparison between them, the discussion last Friday would have assumed a more critical tone than it did. In addition, it would have been made clear that the temperatures which Mr. Herbert measures with his very ingenious thermo-couple system are definitely not those which, from the original paper, we might very readily be led to believe them to be.

The "Whitaker ring" observed at the end of a bar being surfaced—an illustration of such a ring will be found in our report on page 239—is, according to Mr. Herbert, caused by the fact that at a certain cutting speed the temperature produced in the work-metal by the action of the tool upon it reaches a range at which the work-metal shows a decided tendency not to harden when worked. The ring is produced while the cutting speed and the temperature induced by it are passing through the "free-cutting range." That range, says Mr. Herbert, coincides with the fall in work-hardening capacity exhibited by the work-metal when tested at various temperatures by means of the "pendulum" hardness device. If the reader will refer to Fig. 2 on page 239, a reproduction of one of Mr. Herbert's slides, he will find that the temperature recorded by the thermo-couple system while the Whitaker ring is being produced is about 370 deg. Cent. If, however, he will turn to Fig. 7, showing the work-hardening capacity of the metal at different temperatures, he will observe that the dip in the curve, the D2 depression as Mr. Herbert calls it, occurs, not at 370 deg., but somewhere about 150 deg. Cent. These two figures are so far from being coincident that we felt obliged to seek Mr. Herbert's explanation of their lack of agreement, a lack of agreement which we believe was not generally observed at last Friday's meeting. The explanation which we have received seems to alter the light in which we should regard Mr. Herbert's experiments. Although we could quote from the original paper to show that it conveys the contrary impression, Mr. Herbert does not claim that his thermo-couple system enables him to measure the temperature induced *in the work* by the action of the cutting tool. It enables him, he says, to measure the temperature generated by friction between the tool and the chip while it is being severed from the work. That temperature, as shown by the thermo-couple record, may be as high as 370 deg. Cent. But the temperature in the work-metal in advance of the tool before separation of the chip occurs is much less. It is this advanced temperature, Mr. Herbert argues, which affects the machinability of the metal and which coincides with the temperature of 170 deg. or other value at which the work-hardening capacity curve shows a minimum value. There is nothing so far as we can see unreasonable in Mr. Herbert's argument, but if we accept it, we must revise our estimate of the value of his research methods and the results they have so far yielded. The practically important factor to be determined is the temperature generated in the work and affecting its machinability. Mr. Herbert's methods, in spite of any impression to the contrary that may have been gathered, leave that temperature as indeterminate as ever it was. His statement that it coincides with the temperature at which the work-hardening capacity reaches a minimum value when Whitaker rings are formed is not founded on any fact or measurement given in his paper either as published or amplified. It may well be, and very probably is true, but its truth has yet to be proved. The temperatures recorded by the thermo-couple system are tool temperatures only. They are of value in an investigation of the wear and general behaviour of tools. But as guides to the critical temperatures occurring in the work they must remain of very little value until the correlation between the temperatures which Mr. Herbert measures and the temperature of the work is established.

Regarded as tool temperatures and not as work temperatures, Mr. Herbert's measurements are less conclusive and somewhat less enlightening than we at first thought them to be. In addition, they are open to criticism of a kind that otherwise they would escape. In calibrating the thermo-couple systems Mr. Herbert clamped or welded a piece of work material to the tool, and inserting the two in an electric furnace compared the electromotive force given by them at different temperatures with that generated by a standard iron-constantan thermo-couple. This method of calibration would be open to no objection if the temperatures to be measured were those in the work-metal in its normal state before being modified in any way by the action of the tool. In other words, the calibration method would be sound if the temperatures measured were those which from the original paper we believed Mr. Herbert was intending to measure. But if the temperatures measured are, as they now appear to be, those generated between the tool and the chip, the calibration method is unsound and involves an assumption of a highly debatable order. The hot junction of the thermo-couple system is clearly constituted by the metal of the tool and the metal of the *chip*. Thermo-couples are well known to be very susceptible to slight chemical and physical changes in the metals of which they are composed. It is therefore most unlikely that the metal of the chip behaves thermo-electrically in exactly or even approximately the same manner as the metal of the work. Although the one originates from the other, they are physically in entirely different conditions and there would be nothing surprising in the fact if they were also found to be quite different in chemical constitution. It may well be the case that to use the chip instead of the undeformed work-metal as one

element of the thermo-couple in the calibrating furnace would introduce difficulties and uncertainties of an insurmountable nature. If the chip for calibration purposes has to be heated up to 600 deg. Cent. it is reasonable to suppose that during the process its constitution will suffer considerable change. The release of the strain and the molecular rearrangement produced by the virtual annealing process experienced during the calibration may conceivably generate an electromotive force quite apart from that commonly used as an indication of temperature. If such is the case—and known facts concerning the phenomenon of piezo-electricity strongly suggest that it may be so—all attempt at calibration would appear to be futile. The more, indeed, the subject is examined the more prominently do the difficulties in the way of measuring cutting temperatures stand out and the more obvious does it become that no method so far proposed or tried for the purpose is free from very liberal assumptions.

Variety in Design.

No one expects more than a general resemblance to exist between machines built for the same purpose by different makers. Even supposing that they are kinematically the same, with corresponding shafts, levers, wheels, &c., that is quite as far as resemblance is likely to go. That equivalent parts should be interchangeable would be a coincidence outside the bounds of probability, while that they should be identical as to every detail would be regarded as in the nature of a miracle. Yet, if the machines have been built for the same purpose, it is fair to ask why they should be so different. It is logical to contend that, as there can be only one line representing the shortest distance between two points, so there can only be one way of arriving most directly at a given result from the starting point of certain data. Any divergence from this unique method would be an error in the technical as much as in the etymological meaning of the word. But this conclusion only follows if the premises are granted. We have to be sure that the result aimed at in each case really is the same and that the initial conditions imposed on the designers are identical. If one designer gives different relative values to questions of efficiency, weight and cost from the other, or if he has to conform to different manufacturing conditions, the cases are not comparable and identical designs are not logically to be expected. Furthermore, many of the variations which will be found between two designs, although apparently great, may be so trivial in their effect upon efficiency or cost that they may be regarded as negligible. Much of the variety in designs of machinery put forward for the same duty may be explained by the considerations we have mentioned, but there will nevertheless always remain a very large residue for which no such explanations seem to serve. It would be a good thing if every time a designer found that somebody else had adopted a different solution from his own for any mechanical problem, he regarded it as a matter for careful thought. Being different, it is likely to be either better or worse than his own solution. Possibly the sum total of its defects might appear to equal its advantages, so that there might be little balance on the whole. Even so the question would be worth some detailed consideration. Every advantage that the rival design possessed, whether in cost, efficiency, weight, size, or appearance, should be a challenge to be met, not by gloating over the corresponding defects, but by seeing whether the advantage was not obtainable without them. Take, for example, such a simple case as that of an air compressor piston. There are probably half-a-dozen approved ways of making it and fixing it to its rod. They cannot all be equally good, and even if the best is only fractionally better than the others, it should be adopted by those employing less advantageous methods.

There are too many manufacturers who are inclined to meet every suggestion that their designs might be improved with the statement that the detail complained of is their "standard practice"—as if that made it any better! No sensible man would alter anything for some problematical or insignificant advantage. But when "standard practice" is little more than synonymous with "bad habit" the sooner it is reformed the better. Standard practice is too often merely the crystallisation of some way of doing things, appropriate possibly at first on account of special conditions, or perhaps only representing the ill-considered idea of some junior draughtsman. Copied from one design to another and hallowed by antiquity, it becomes eventually nothing but a drag on progress. A few shillings spent on altering a pattern, or perhaps only a drawing, would often save hundreds of times the cost of the alteration, especially where repetition work is concerned. Bed-plates that have to be planed on two or three different levels, when all the machining might just as easily have been done on one level; castings that require core boxes when they might have been equally well designed otherwise; studs used to hold things when bolts would have been better; and dozens of other instances of bad design are perpetuated every day under cover of the words "standard practice." Few things would be more advantageous, for some firms, than a serious inquest into every one of their standard designs. As the designs have become standard, it may be taken for granted that they are reasonably efficient, and give satisfaction to customers. Should there be no likelihood of making any improvement in these respects, there is always the question of whether the articles cannot be manufactured more cheaply, and here it is that the drawing-office often has more power than the shops. The inquest suggested should be a drastic one, the designs being considered both as a whole and then minutely detail by detail. The men responsible for making the things should be the critics, with the drawing-office on the defensive. Why, for example, should a certain fixing not be designed so as to register itself, instead of having to be lined up and then located with dowels? Why should there be a quarter of an inch difference in length between otherwise similar motion pins on a particular machine, and why should these pins differ in design from one machine to another? Why should the holding-down bolt bosses be made so that loose pieces are required on the pattern, with all the chances of getting them shifted in the mould? Indeed, why should there be any bosses at all for these bolts?

One could go on almost indefinitely illustrating the kind of questions as to the why and wherefore of various details which would be raised at such an inquiry. Enough, however, has been said to indicate the lines it might profitably take. That it would be beneficial in almost any works there can hardly be a doubt. It would give the production manager and the shop foreman just the opportunity they need of bringing to the notice of the designers the kind of things which lead to needless cost, trouble, and bad workmanship. Very frequently indeed the proposed changes would have the fullest sympathy of the drawing-office, whose only excuse for the criticised design would be that of Dr. Johnson for an error in his dictionary: "Ignorance, pure ignorance." In cases where efficiency and ease of manufacture were antagonistic the best compromise would be arrived at, and when a certain standard practice had become justified by the existence of special jigs and tools which counteracted its manufacturing defects the men from the shops would be the first to wish to see it undisturbed. Otherwise it would go the way of all fetishes. The net outcome of a detailed criticism of designs along the lines we have suggested would be twofold. In the first place, by reducing useless variety and eliminating worse than useless manufacturing difficulties, it would tend enormously to cheapen production. Its other effect would be on the drawing-office staff. It would impress upon designers the things that really matter in their work. In practical engineering the efficiency of a machine in the text-book sense is a secondary matter. The first requisite is that it shall be made at a price at which it can be sold, and the next is that it shall be reliable in its operation. Only after these comes its theoretical efficiency. However much attention may have been given to this, the design is bad unless sufficient cheapness and reliability have been obtained. A discussion of its details from the practical point of view would also help to avoid senseless variety and complications in future designs. There would still be ample scope for that individuality of appearance which is so often a commercial asset. The bounds of good engineering are sufficiently wide to embrace plenty of alternative designs, each perhaps more appropriate than any other to the conditions of some particular manufacturer. Nor need there be any fear that the elimination of designs which are bad from the manufacturing point of view would reduce the beauty of the world. Beauty is perfectly consistent with sound engineering; indeed, in a mechanical structure it cannot exist without it. "The thing that looks right is right" is a phrase which expresses this instinctive feeling. By the elimination of those varieties of design which are demonstrably inferior, although perhaps not so bad as to be unsaleable or unworkable, we should be quite as far as now from a dull uniformity, but much nearer to a higher level of engineering practice.

SIXTY YEARS AGO.

IN our issue of February 23rd, 1866, we recorded the launch, on the 19th, of the "cigar ship" at Messrs. Hepworth's Yard, Isle of Dogs. The idea of constructing a ship resembling a cigar in shape originated with Mr. William Winans, an American engineer well known in connection with the railway system of Russia and the United States. The scheme had been before the world for seven years. The vessel launched at the Isle of Dogs was the fourth built to Mr. Winans' proposals, the first having been tested in January, 1859. Although much praise and more abuse had been heaped upon the idea no scientifically full and accurate account of the objects it was intended to fulfil had been published before the appearance of our article. The ship was intended to combine the qualities of speed, safety, economy, and comfort in a pre-eminent degree. Made in the form of a circular spindle—so we described it—and being water-tight all over, it was believed that it would behave in a heavy sea much after the manner of a corked bottle. Speed, it was expected, would be secured by reason of the great length of the vessel relatively to its immersed cross-section and by virtue of the reduced surface offered to resistance. The shape of the hull presented no flat surfaces to the impact of the waves, and with the deck openings battened down seas might break over the vessel without endangering its safety. In hard weather trim, we wrote, the cigar ship might be submerged several feet below the surface of the water for a quarter of an hour without serious inconvenience to those on board. It was, however, so we said, a popular mistake to believe that the ship was intended to pierce the waves rather than ride over them. As an accidental consequence of its shape the vessel might occasionally pierce a wave, but it was not intended that it should normally do otherwise than ride over the waves. The vessel had a displacement of 500 tons. From point to point its length was 256ft., while the draught fully loaded was 10ft. 6in. At the centre the hull had a diameter of 16ft. The taper towards each end followed a plan which "a long course of experiments had demonstrated gave a minimum of resistance." The hull proper was 224ft. long and ended in discs 4ft. in diameter, each with a stuffing box at its centre for the screw shaft. The propellers, 22ft. in diameter, were provided with conical bosses, each 16ft. in length, and continuing the taper of the hull to a sharp point at each end. On top of the hull was an upper deck or platform, 10ft. 6in. wide amidships and 130ft. long, provided with bulwarks 2ft. 6in. high all round. Two short funnels, two telescopic masts, a couple of galleys and companions for the use of the crew and passengers completed the deck equipment. In subsequent issues we gave details of the luxurious internal equipment of the vessel and of its remarkable machinery. The first cigar ship, it may be remarked, had its propeller at the centre of the hull in a gap formed to receive it. It was built at Baltimore in 1858, and was credited with a speed of 17½ knots. It was not, however, altogether as successful as anticipated, and a second vessel on a modified plan was built at St. Petersburg, provided with a single small propeller wholly submerged beneath its hull. It attained a speed of 9 knots. A third vessel, representing an improved edition of the second, was built at Havre and launched a month or so before the Isle of Dogs ship.

BOOKS RECEIVED.

Carburation et Carburateurs. By L. Poincaré. Paris: Gauthier Villars et Cie., 55, Quai des Grands-Augustins. Price 22f. net.

Pyrometers. By Ezer Griffiths. London: Sir Isaac Pitman and Sons, Ltd., Parker-street, Kingsway, W.C. 2. Price 7s. 6d. net.

Applied Electricity. By S. Timoshenko and J. M. Lessells. East Pittsburg: Westinghouse Technical Night School Press, Pa., U.S.A.

The Mines (Working Facilities and Support) Act, 1923. Part I. London: The *Colliery Guardian* Company, Ltd., 30, Furnival-street, E.C. 4.

Self-instruction for Students in Gas Supply. Third edition. By "Mentor." London: Ernest Benn, Ltd., 8, Bouverie-street, E.C. 4. Price 10s. 6d. net.

The Smoke Problem of Great Cities. By Sir Napier Shaw and J. S. Owens. London: Constable and Co., 10 and 12, Orange-street, W.C. 2. Price 22s. 6d. net.

Introduction to Theoretical Physics. Volume II. By A. Haas, translated by T. Verschoyle. London: Constable and Co., 10, Orange-street, W.C. 2. Price 21s. net.

Questions and Answers for B.O.T. Examinations on Marine Oil Engines. By W. C. MacGibbon. Glasgow: J. Munro and Co., Ltd., 35, Washington-street.

The Enlarged Heat Drop Tables. By H. Moss and Professor H. L. Callendar. London: Edward Arnold and Co., 41 and 43, Maddox-street, W. Price 10s. 6d. net.

Practical Surveying. Thirteenth edition. By G. W. Usill, revised by G. L. Leston. London: Crosby Lockwood and Son, 7, Stationer's Hall-court, E.C. 4. Price 7s. 6d. net.

Hütte Taschenbuch der Stoffkunde. By Akademischen Verein E.V. and Dr.-Ing. A. Stauch. Berlin: Wilhelm Ernst and Sohn, Berlin, W. 66, Wilhelmstrasse 90. Price 22.50 R. Marks.

Report on the Financial, Commercial and Economic Conditions of the Argentine Republic. By H. O. Chalkley. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 2s. 6d. net.

British Industries Fair.

No. II.*

IN continuing our description of the exhibits at the Birmingham section of the British Industries Fair, which, by the way, closes to-day—Friday, the 26th—it may be as well first to dispose of those internal combustion engines with which we were unable to deal last week.

Vickers-Petters, of Ipswich, are showing several oil engines, among which the most important is that illustrated in Fig. 9. At the Fair, however, the engine is coupled directly with a 60-kilowatt generator

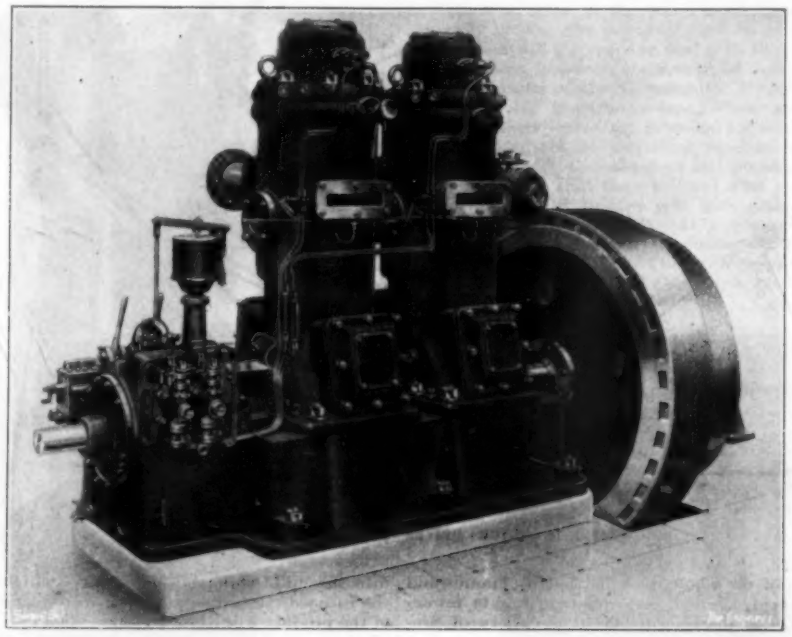


FIG. 9—100 B.H.P. HEAVY OIL ENGINE—VICKERS-PETTER

by the Metropolitan-Vickers Company. The engine, which is of 100 horse-power, has, it will be seen, two cylinders, and has much the same general appearance as engines by the same firm that we have described in the past. Several modifications and improvements have, however, been made in the present model. One of the outstanding features is the arrangement of the water-cooling jacket for the cylinder head, which is formed by means of a separate outside casting bolted on to the cylinder head with a flanged joint, so that the cover can be easily removed and the inside surfaces exposed for scaling. Another improvement in the way of cooling is the adoption of a water passage round all the crank shaft bearings—a policy which this company has hitherto confined to marine engines.

Petters, Ltd., of Yeovil, are sharing the last mentioned stand and are exhibiting a 16-20 brake horse-power twin-cylinder marine engine, fitted with reversing gear, a 12-14 horse-power cold-starting oil engine, a 5 brake horse-power agricultural engine for petrol or paraffin, and an electric lighting set.

The two engines on the stand of Babcock and Wilcox, Ltd., Farringdon-street, London, E.C. 4, one of which is illustrated by the engraving—Fig. 10—are also of the cold-starting two-stroke type, and are made to the designs of Clayton and Shuttleworth, Ltd., of Ipswich. One of the chief peculiarities about this engine is the adoption of a stepped piston, that is to say, one having a normal working face and a secondary annular area within a correspondingly increased bore. This arrangement has a two-fold advantage in that it provides a large area, working in conjunction with the crank case for the compression of the scavenging air, and also provides a very satisfactory means of starting the engine with compressed air. One of the disadvantages of starting many oil engines by means of compressed air is, of course, the chilling effect on the cylinder walls, which is produced by the expansion of the compressed air, and has to be counteracted by increasing the compression pressure beyond the point that would otherwise be chosen for normal running. In the case of the engine under review, however, the annular part of the piston provides ample area for starting up with compressed air and, at the same time, isolates the space behind the annular piston is normally in communication with the atmosphere, and is only closed up when it is required for starting purposes. Then the movement of the hand wheel, shown in the front of the engine, closes the atmospheric opening and connects the starting air valve with its cam gear. As soon as the engine has got under way the wheel is reversed and the air valve is put out of action, while the fuel pump is connected with its excentric rod. The engine exhibited is of 50 brake horse-power, and the makers guarantee that its fuel consumption will not exceed 0·45 lb. of Diesel fuel oil per brake horse-power per hour.

Fielding and Platt, Ltd., of Gloucester, have a couple of oil engines, one of which is a new model of 12 maximum horse-power, or 10 horse-power working load. It is illustrated in the half-tone engraving—Fig. 12. It is noteworthy, in connection with these engines, that although most other makers have adopted electrical or cartridge devices for starting four-cycle engines, this firm still adheres to the old hot tube for igniting the first few charges. It contends in its favour, that in the event of a miss on first trying to start the engine, the oil of that charge will drop down into the bottom of the hot tube and will evaporate harmlessly, instead of producing a very violent explosion, as may be the case if several successive charges accumulate in the cylinder before the first firing takes place. As a result of the assurance of starting given by the hot tube, it has been found possible to reduce the explosion pressure to 350 lb. per square inch, while the mean effective pressure is down to 76 lb. per square inch in the case of engines of 50 brake horse-power, or thereabouts. For the purpose of heating the tube on starting up a small stream of air is taken from the compressed air reservoir, and is used to produce a Bunsen flame with oil that gives enough heat in two minutes to get the engine under way. The pressure of air necessary for starting is 120 lb. per square inch.

Tangyes Ltd., of Cornwall Works, Birmingham, have a stand on which there are exhibited a couple of oil engines and a large variety of pumps, both centrifugal and reciprocating. The engines, one of which is capable of developing 47 brake horse-power, while the other is of 18 horse-power, are both intended for running on heavy fuel oil. The larger set is of the four-cycle cold-starting type, and is got under way without the help of any extraneous heat. The engine is put into motion, at starting, by compressed air in the usual manner, but as the air in the cylinder at the end of the compression stroke would not be sufficient to bring about ignition of the injected fuel oil, a small quantity or super-charge of air is admitted to the cylinder at or about the beginning of the compression stroke, which causes the pressure of the air charge to be raised to such an amount that ignition of the fuel oil will take place. The admission of the super-air is continued only during the starting of the engine, and takes some ten to fifteen seconds. During this period the combustion chamber has become sufficiently warmed so that when the super-compression starting valve is put out of operation, the combined heat of the now warm combustion chamber and the heat obtained at the lower compression is sufficient to bring about ignition of the injected fuel oil, and the engine continues to run in the normal way.

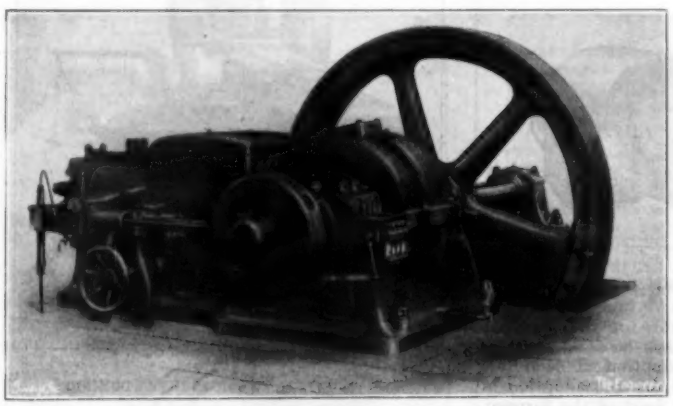


FIG. 10—50 H.P. COLD-STARTING OIL ENGINE—BABCOCK AND WILCOX

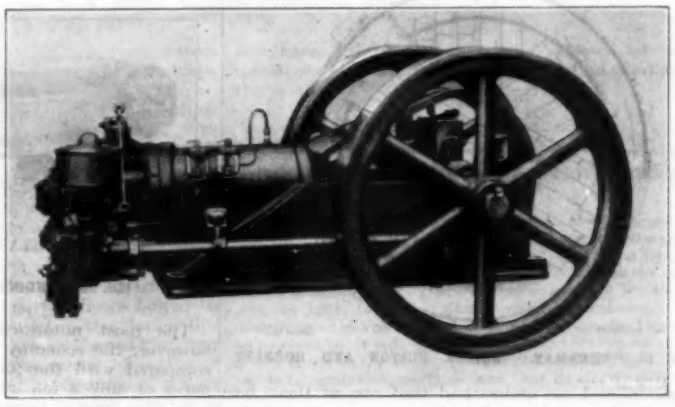


FIG. 12—12 B.H.P. CRUDE OIL ENGINE—FIELDING AND PLATT

These engines are started cold by means of a small coil of resistance wire, tucked into a hollow plug, which is heated by low-voltage electric current. When the engine is running the current is, of course, switched off and the coil is sufficiently protected by the plug to prevent its being burned away by the explosion temperature. The makers claim that one of the great merits of these engines is the comparatively low explosion pressure, which, they say, is 30 per cent. less than that of the average cold-starting engine, while the mean effective pressure is correspondingly reduced, which naturally results in a long life for the working parts. The fuel consumption is, nevertheless, quite satisfactory, being of the order of 0·42 lb. of heavy fuel oil per brake horse-power per hour.

* No. I. appeared February 19th.

the chilling effect from the explosion chamber. The transfer passage from the crank case is also used for the admission of the necessary air, and is provided with a large valve area for the purpose. The air is, however, first drawn through passages in the bed-plate to help in keeping the engine cool. The top half of the crank case is a casting which can be readily removed, and when it is taken off not only is the big end of the connecting-rod fully exposed but the stepped part of the piston can also be got at for dismantling. With the step piston taken off, the working piston can then be drawn out at the back of the cylinder in the usual way, instead of having to be brought forward after the crank shaft has been got out of the way, as is common with some stepped piston engines. It should be mentioned, by the way, that By means of this system of starting the engine, it will be gathered that, although the air in the cylinder is compressed to such a pressure as to bring about ignition when starting from a cold state, this compression is considerably reduced during the normal working of the engine. The compression during the normal working is, in fact, some 20 per cent. below that required for starting, and the pressure on the bearings is, of course, correspondingly lessened.

The smaller engine on the stand is of 15 horse-power, with lamp ignition, and is the largest size of that type made by the firm at present, but we learned on the stand that a new model of 20 horse-power will be added very shortly.

Among the ram pumps shown on this stand there is a very neat little new model intended for such

purposes as supplying cooling water to the cylinder jackets of internal combustion engines. It has a ram 2¼in. by 2¾in. and runs at 90 revolutions per minute. It is of the vertical type, with the crank shaft overhead, and has india-rubber valves with brass guards. The valve seatings are of brass, and the spindles of Muntz metal.

The remaining oil engine to which we must make reference is that on the stand of Ruston and Hornsby, Ltd., Lincoln. It is considerably the largest in the Exhibition, being of 130 brake horse-power, and is shown just turning over, running light, in a quite impressive fashion. The engine is of the horizontal type, and is so familiar to our readers that we need not describe it here in detail. There is also a three-cylinder vertical oil engine of 45 brake horse-power, shown stationary, and a little air compressing set for starting up the big engine. On this stand there is also an example of the "Thermax" boiler—see Fig. 13—which the makers adopt for such services as steam

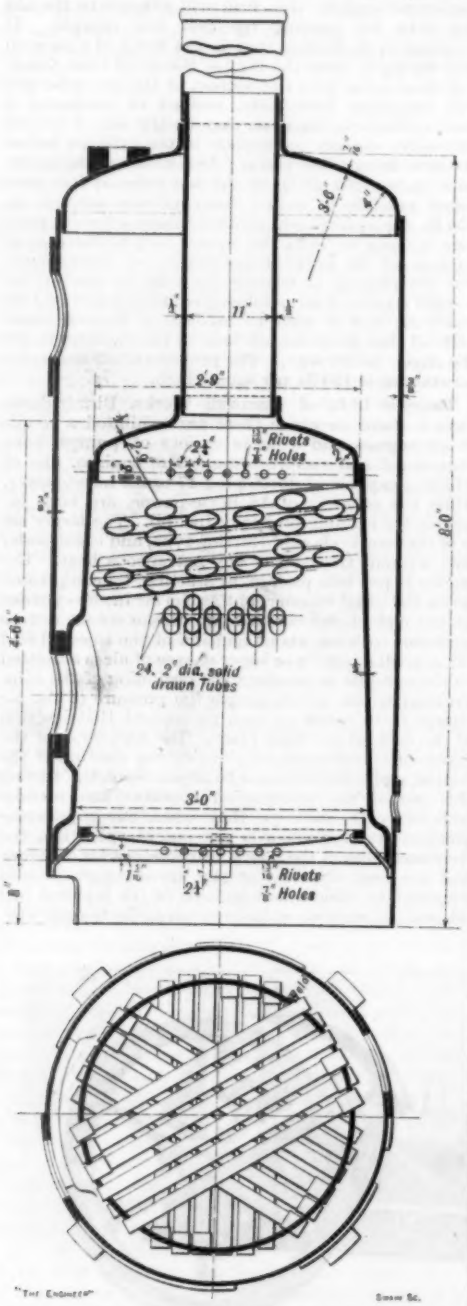


FIG. 13—"THERMAX" BOILER—RUSTON AND HORNSBY

navvies, and we understand that one of them has recently been subjected to the severe test of being submerged in sea water every high tide and having steam raised in it every low tide. As will be seen from the drawing, the usual large cross tubes of a vertical boiler have been replaced by nests of comparatively small tubes, set at a slight inclination; but one of the outstanding features of the boiler is the generous provision of manholes. The doors are so arranged that all the tubes can easily be got at for inspection or cleaning, while there is good access to the heating surface of the fire-box and flues. These boilers are made in a number of sizes ranging from 6ft. 9in. high by 2ft. 9in. in diameter up to 14ft. high by 5ft. 7in. in diameter.

Passing on now to the more general exhibits at the Fair, there is a new departure for Dennis Brothers, of Guildford, in the production of a motor lawn mower, a line drawing of which we give in Fig. 14. This machine is driven by a four-stroke 4 horse-power petrol engine through a pair of countershafts, which are connected together by silent chain gearing, having a ratio of about 4 to 1. The high-speed shaft connected with the engine is used to drive the grass-cutting "cylinder," while the slower shaft is used for the travelling roller. There are, however, friction clutches in both drives, so that the cutter can be put out of action and the machine used as a simple roller. It is noteworthy that the driving roller is made in three sections, longitudinally, and that each section is fitted with a differential gear, which naturally results in the machine being very handy in turning corners. The power of the engine is, we are told, ample to drive the machine and haul an attendant, perched on a trailer, up steep gradients.

A stand of unostentatious appearance, but one on which we had some of the most interesting con-

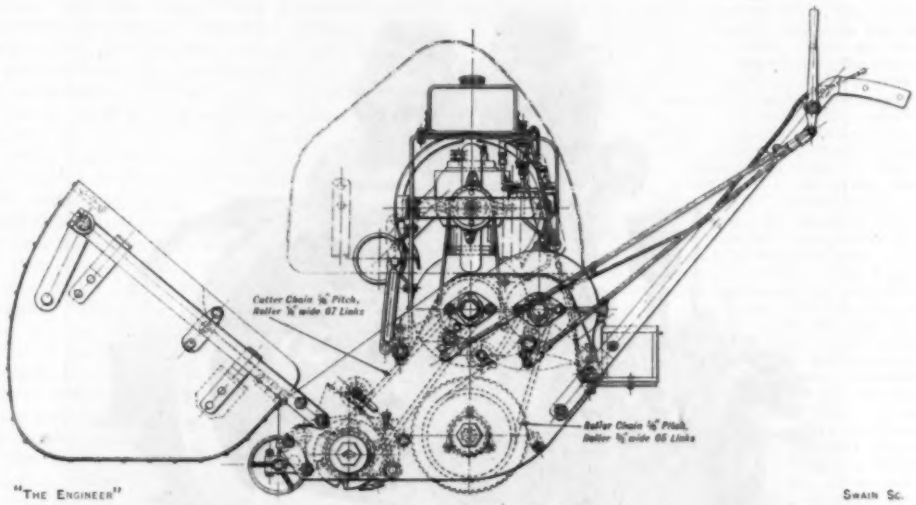


FIG. 14—MOTOR-DRIVEN LAWN MOWER—DENNIS

versations of the whole week, is that of Timmis and Co., Stourbridge, which is devoted entirely to refractories. On it there is displayed a variety of fire-bricks and bricks for heat-insulating purposes; but the charm of the stand lies in a representative who can discuss the theoretical side of furnace design in a general way and bring forward accomplished facts to substantiate his theories. The company claims to produce a brick which will withstand the temperatures attained in powdered fuel furnaces, provided that they are reasonably designed, at a price, certainly above that of ordinary fire-brick, but much below that of the materials produced in the electric furnace.

Another firm concerned with refractories is that of Gibbons Brothers, Dudley, Worcs., which claims to be one of the few companies in the world that makes the whole of the requirements, whether metallic or mineral, for the production of a furnace. The main exhibit on this stand is a gas-fired hardening shop for motor car gears and such like articles, shown in operation, in which the charging and discharging is effected by means of an electrically operated machine.

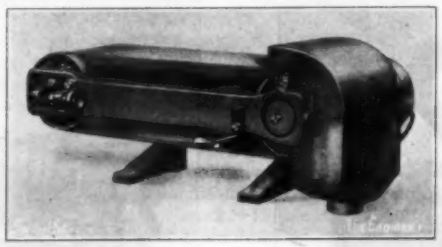


FIG. 15—SANDING MACHINE—DOMINION

The most noteworthy feature of the plant is, however, the economy which has been effected, as compared with the fuel consumption of such furnaces of only a few years ago, by the adoption of insulating bricks, to retain the heat of the furnace, and the use of recuperators to heat up the air necessary for burning the gas. The recuperative process, we were told, has been carried to such an extent that it was found that if the gas, also, was warmed before it was burned, dangerously high temperatures were produced. Apart from the direct economy in fuel possible with these modern furnaces, they have the advantage that they retain their heat well during the week-end shut-down, and require a correspondingly short time for starting up again.

Close by the stand last mentioned there is that of the Incandescent Heat Company, Ltd., of Cornwall-road, Smethwick, which is also devoted to gas-fired furnaces. In this case, however, less effort is made to conserve heat over long running periods, but rather to provide apparatus which can be raised to temperatures of, say, 1600 deg. Cent. as quickly and economically as is possible for forging, welding and similar purposes.

More or less allied, in character, with the last two exhibits is that of the Atomised Fuel and Engineering Company, of 82, Victoria-street, Westminster. It comprises a machine for powdering coal, for furnace firing, which, the makers claim, is as effective as a large power station plant, but yet can be put to work economically on a comparatively small scale. The machine has two rotors driven by an electric motor at a speed of from 200 to 250 revolutions per minute. The first rotor is of the simple radial beater type, and takes the coal at about 1½in. cube. From this section the fuel goes to another compartment, in which a number of balls are driven round by radial arms to pulverise it very finely. A strong current of air is produced by a fan to pull the material forward into a separator, which allows the oversize to drop back into the mill, while the fine stuff is sent forward to the furnace. The makers guarantee that 85 per cent. of the product will pass through a 200 mesh sieve and 95 per cent. through a 100 mesh.

One of the few stands at the Fair on which there is exhibited any woodworking machinery is that of the Dominion Machinery Company, Union-street South, Halifax, on which there are the three machines illustrated in Figs. 15, 16 and 17. They comprise a sanding machine or "linisher," as the Americans would call it—see Fig. 15, which is the latest production of the company and needs little description. It has, it will be seen, a hood for taking away the dust and both spindles are mounted on ball bearings, so that it runs very freely indeed. The machine shown in Fig. 16 is a combined surfacer and saw, and is driven by a 3 horse-power electric motor. The motor drives the cutter spindle of the surfacer, on the

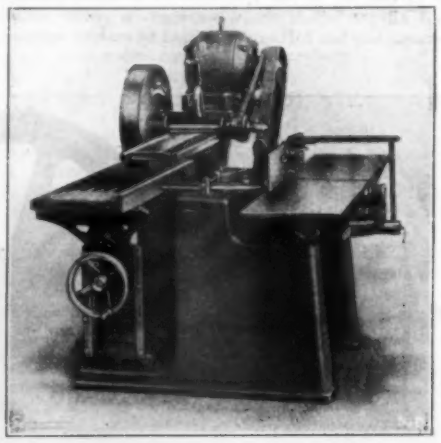


FIG. 16—ELLIOT WOODWORKER—DOMINION

right, by a flat belt, and the saw spindle on the left, through a V band. The surfacing cutter, by the way, is 12in. wide. The motor and saw spindle are mounted on a carriage on a long slide, so that, with the surfacer belt removed, they can be pushed along the slide. The slide, in turn, can be rotated about a vertical pivot for cross cutting or mitreing with the saw, or, of course, a fly cutter can be put in place of the saw for gaining and many other operations, while the opposite end of the spindle is fitted with a chuck for drills. The motor is powerful enough to drive both sides of the machine at the same time. The morticing machine shown in Fig. 17 is a new type brought out by this company and combines a chain cutter with a hollow square drill for clearing out the round corners produced by the chain cutter. It is chiefly noteworthy on account of the convenient arrangements made for using either or both of the cutters according to requirements.

Alfred Herbert, Ltd., of Coventry, has a great variety of tools, chucks, and so forth, together with the Ashdown Rotoscope, which was described in THE ENGINEER of September 11th, 1925; but the most interesting part of this exhibit is a selection of high-power milling cutters. One example is shown in Fig. 18, which represents a cutter 6in. in diameter by 2½in. wide, intended for cutting on the face and sides simultaneously. It is divided in the centre for convenience in grinding and has, it will be seen, very strong teeth. The most noteworthy feature of the

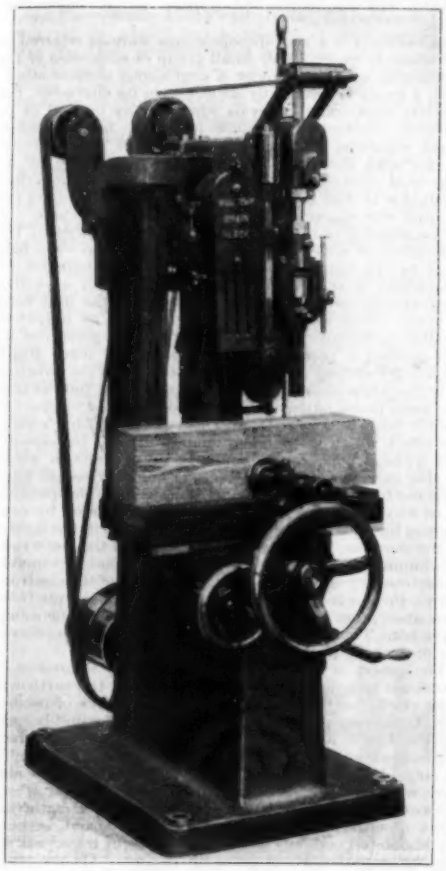


FIG. 17—COMBINED CHAIN & CHISEL MORTICER—DOMINION

cutter is, however, the provision of a rake in the cutting edge, similar to the top rake of a turning tool, while the spiral angle is as great as 35 deg. It will be noticed incidentally that the corners of the teeth are slightly rounded to prevent them breaking off. The result of this design is that very heavy cuts can be taken and the cutter shown in Fig. 18 has been used on a cut 1¼in. deep in mild steel with a feed of $6^{7}/_{16}$in. per minute when it was running at 48 revolutions per minute. Another very heavy cut is illus-

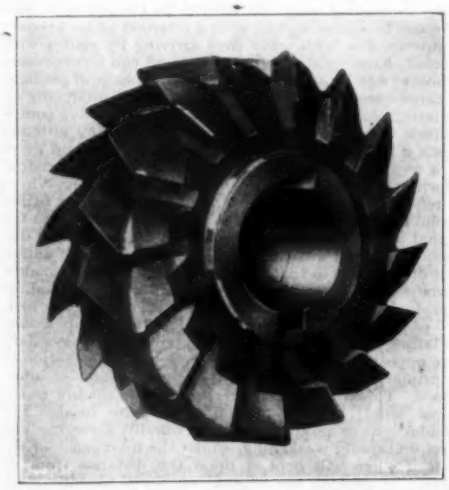


FIG. 18—SIDE AND FACE CUTTER—HERBERT

trated by Fig. 19, which shows two gangs of these cutters milling out back tool-posts for Herbert lathes from rectangular bars. In this case the cross-sectional area of the cut through each bar is approximately 7½ square inches, so that a total of 15 square inches of metal is being removed, and the feed is at the rate of ¾in. per minute. Tests carried out by the makers to determine the efficiency of these cutters show that they will remove as much as 22 cubic inches of mild steel in a minute when absorbing 27·7 horse-power. The cutter in this case was 4½in. in diameter by 9in. long and was driven at a peripheral speed of 70ft. per minute.

The Brooke Tool Manufacturing Company, Ltd., of Greet, Birmingham, also, is exhibiting a number of high-power milling cutters in which the same principle of coarse pitch teeth with a steep spiral is adopted. There are also on this stand several examples of inserted tooth cutters in which the cutting edge is ground after the cutters are put in place in the arbour, so that a true spiral is formed. A new tool by these makers is a very simple form of adjustable reamer, in which the adjustment is effected by means of an internal cone. These reamers are made in a great range of sizes up to 3½in. in diameter with flutes 4in. long.

Around the sides of Building "B" at the Fair there is a number of smaller stands, but they are, nevertheless, some of the most interesting, as they generally display the pioneering efforts of inventors, but we have not the space to deal with them in detail. Among them, however, there may be mentioned the abrasive blocks of the Commutator Grinding Block Company, 16, Sugarhouse-lane, Greenock, which, as the name indicates, are intended for smoothing up the commutators of electrical machinery. These blocks are made of an abrasive and bonding medium so proportioned that they will not load up with the copper ground off, neither will they glaze over and loose their cutting quality. At the same time the abrasive is hard enough to cut down high mica insulation quite readily. The representative of the firm on the stand told us that these blocks can be used satisfactorily on either turbine-driven generators running at full speed or, at the other end of the scale, on large slow-speed motors.

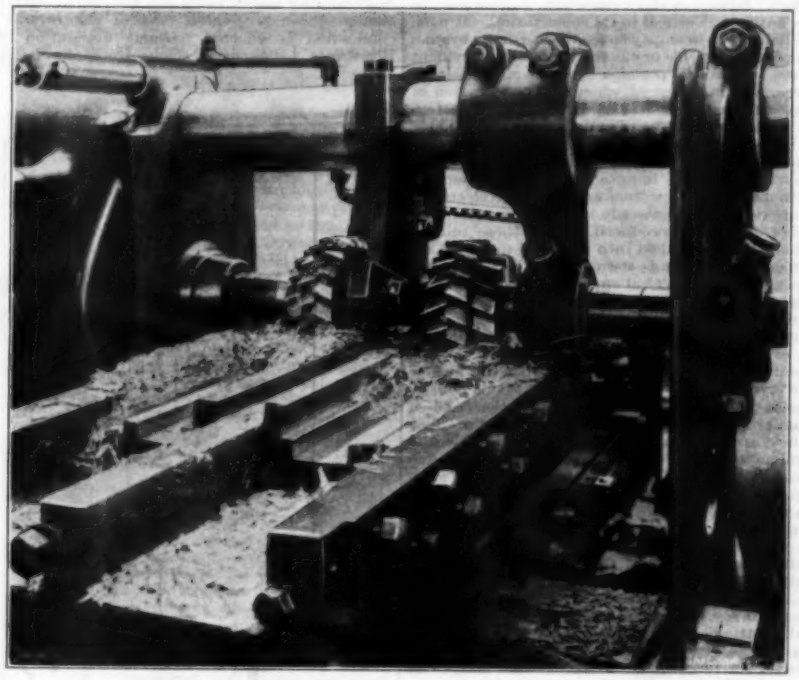


FIG. 19—A HEAVY MILLING OPERATION—HERBERT

Another exhibit in this part of the Fair which should appeal to engineers who are confronted with speed-changing problems is that of Barker and Co., Halstead Works, Great Horton, Bradford. It is a working example of expanding pulley change-speed gear, on much the same principle as that of the Lang lathe, but it has a special form of belt. The driving face is, of course, the edge of the belt, which bears against the inside faces of the coned pulleys. The edge is formed as a series of facets of leather riveted on to aluminium alloy castings, which are bolted to the belt proper. The peculiarity in the design lies in the fact that the castings are so shaped that the pull of the belt comes truly in the centre of action of the pad in contact with the pulley. The result is that there is no tendency for the pads to cant over, as is the case with some forms of V belt, and a very high coefficient of transmission is obtained. We made some rough experiments with the belt on the stand, and although they cannot be said to have been conclusive, they indicated that the Barker belt is a considerable advance on many others of the type.

On the stand of Henry Beakbane, The Tannery, Stourport, there is a fine exhibit of leather for belting and various other purposes; but one of the most striking exhibits is a set of samples demonstrating the ability of chrome-tanned leather to withstand high temperatures. These samples are what might be described colloquially as windows and frames punched out of one piece of leather, of which the windows were subsequently immersed in hot water. In the case of oak-tanned leather the result is that the "window" is reduced to about one-fourth of its original size, but with the chrome leather the window is still a fair fit in its frame.

Among the other exhibits of a mechanical engineering character at the Fair—we intend to deal with those of an electrical nature in the future—there are some which seemed to us rather disappointing, while others were full of encouragement. Among the latter that of J. B. and S. Lees, Ltd., Albion Ironworks, West Bromwich, which is devoted to a display of hot and cold rolled steel strip and shows that Sweden is not the only country in which such material can be produced. Some of the strips exhibited are only three or four-thousandths of an inch thick by 4in. or 5in. wide, but they are uniform throughout. Another rather interesting exhibit is a revival of the Pitter fan by T.V.E., Ltd., of Station-road, Hounslow. It is really a very old idea, of using narrow aerofoils placed behind one another; but, according to tests made by the National Physical Laboratory, the result is a much higher efficiency than can be attained by many other designs, and it is puzzling to know why such a form of fan has not yet met a greater vogue.

The Aston Chain and Hook Company, of Erdington, Birmingham, has a machine, among those demonstrated on the stands associated with the local Corporation, which is making knotted link chain from steel wire, but, in view of the description we gave last year in connection with wire-working machinery of the machines employed by this company, it is not necessary to enlarge on the process here. The Rapid Magnetting Machine Company, Lombard-street, Birmingham, has a number of machines at work for separating iron and steel swarf from other waste; and Messrs. Sweeney and Blocksidge, Saltley, Birmingham, exhibit several power presses for sheet metal working which are noteworthy on account of the protective devices they embody.

The Propagation of Electric Waves.*

THE so-called Heaviside layer is taken to be defined as a supposed permanently ionised region existing in the upper atmosphere, without the assistance of which the bending of electric waves round the curvature of the earth could not be accomplished. If the article written by Mr. Heaviside, in 1902, for the "Encyclopædia Britannica," and incorporated in Vol. III. of his "Electro-magnetic Theory," be referred to, it will be seen that the whole tenour of the article turns on the ability of waves to accommodate themselves to conducting surfaces, and that he clearly indicates that they climb around the earth's surface quite apart from whether or not an ionised layer exists.

All that Heaviside meant to convey by his reference to a possible conducting layer was that the existence of such a layer might limit the upward expansion of waves and so conserve the wave energy. It was certainly not intended to be used as an alternative method of bending the waves to the earth's curvature. The whole context refutes this interpretation.

It must have occurred to many others besides Heaviside that the rectilinear propagation view could not be reconciled with the everyday aspects of wireless communication, as exhibited by the ability of the waves to reach aerials situated in the backyards of houses in large cities, or of their faculty of accommodating themselves to large and abrupt changes of level in the general contour of the land; in fact, their obvious faculty of getting round, over or through thousands of obstacles which, on the rectilinear propagation view, should prove insurmountable barriers.

It was considerations of this kind which led the writer

* Abstract of paper read by Mr. J. E. Taylor before the Royal Society of Arts on Wednesday, February 17th.

to the view expressed nearly twenty-seven years ago that guided waves are concerned. The guided wave view disposes of the necessity for invoking the assistance of an ionised layer in the atmosphere, whilst it does not deny that some degreb of ionisation may, and indeed must, exist, at least in the sunlit portion of the atmosphere and near the poles where it concentrates. On this view, the effect of such a layer would be largely, if not entirely, a detrimental one. A radical re-adjustment of fundamental ideas is involved, not only of electric wave propagation itself, but as to the cause which produces guidance and its bearing on the every-day uses of conducting wires to guide electric current flow. It also raises the question why there is no such guidance in the case of the minute waves giving light and heat radiation.

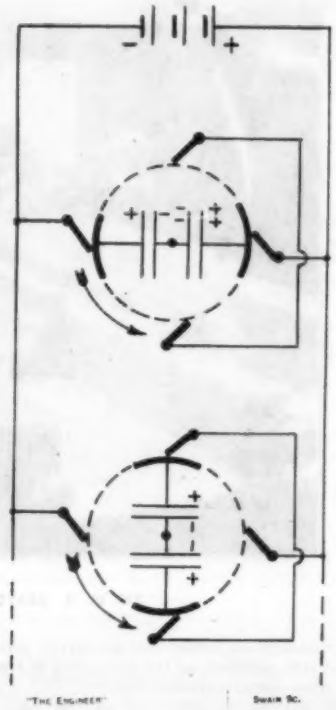
Following the methods of Faraday and Sir J. J. Thomson, the matter will be treated mainly from the electrostatic point of view. That is, Faraday's conception of electric fields of force will be used, but with the underlying modification introduced by Sir J. J. Thomson, which implies that lines or tubes of force are never called into being, but exist through and permeate all space at all times. Normally, they lack organised arrangement and cancel out one another's effects in the gross, except when a preponderance is created in one direction. This modification enables a simple view to be taken of what constitutes a magnetic field. It can be regarded as the momentum of moving tubes of force. Faraday's conception is amplified and completed in other necessary respects by this view. In the main, however, it will be possible to treat of resultant fields only and avoid undue complication. An ether is assumed, but the effects concerned could without doubt be hung on to a space geometry or other conception, if necessary.

For purposes of electrical theory, it is only the electrical aspects of the matter that are of concern to us. Electric forces or electric fields can only be changed by interference from other electric fields. Forces of any other nature are without effect. Hence, in this connection, matter may be regarded as entirely electrical in its constitution. It even appears probable that in empty space there exists a system or network of electric fields or electric stresses, not evident in the gross, which are perhaps systems of self-closed lines of force, and in virtue of which the propagation of electric waves through space is rendered possible. Magnetic force is embraced as being only a particular aspect of electric force, whilst mass or inertia are likewise to be regarded as electrical quantities. The atoms and molecules of matter consist of minute compound systems of electric fields starting from protons and ending on electrons. These minute fields are immensely more intense than any electric fields artificially produced. It is these minute electric fields which are called into play and upon the re-adjustment of which depends the various electrical manifestations occurring in practical applications. To the way in which these fields can re-arrange themselves to produce a gross resultant effect, we must look quite as much as to the motions of electrons. It has always been regarded as something of a mystery why a charge spreads or runs along a conductor, and various views which the author holds to be erroneous have been expressed about deficits of electrons at one place and surpluses at another, and so on. The important fact appears to be that the particular molecular field arrangement spreads, both in the dielectric and the conductor. The lines of force constituting the external field simply slip along the molecular lines of force in the conductor without pulling charges or electrons along with them. Just as when a conductor is moved out of an electric field the lines of force join up and leave the conductor without pulling electrons with them, so the converse effect can take place that the molecular fields of the conductor join up with the external field when the conductor is moved in, without electronic movements being directly involved. That is, the process by which an external electric field slips along a conductor primarily depends on the joining up of successive molecular lines of force with the external field. Only in so far as it is an imperfect one is there any loss of energy in this slipping process. This view is implied by Heaviside, where he draws a clear line of demarcation between "conducted" and "convected" currents, and points out that the current along a metallic conductor is not a convected current.

So far as dielectrics—that is, insulating substances—are concerned, it is common ground that the molecular electric fields are self-contained, or, at any rate, stable, in their character. They are not prone to interfere with one another. The electrical system of one molecule is not upset by coming into relative proximity with that of a neighbouring molecule. It will be understood that molecules are made up by the combination of one or more positive ions with one or more negative ions, the parts of any chemically divided molecule being likewise ions. These ions are, in themselves, compound electrical systems on a smaller scale than the molecular systems.

In electrolytes, whilst the molecular electric systems are unstable, the ionic systems are still stable in general, as in a dielectric. The result of the molecular instablity is that the positive and negative ions are continually changing partners in the course of the normal molecular activity, evidenced as temperature. Apart from the application of electric stresses, the interchange is chaotic, but when stress is applied the interchange becomes more or less organised, and an "ionic drift" is produced determining a deposition of positive ions at one pole where the stress is applied and negative ions at the other. The interchanging of ions in a substance constitutes "ionisation." The law of increase of conductivity with increase of temperature in electrolytes is obviously complied with on this view. The imposition of a drift on the normal chaotic interchange does not involve dissipation of energy. Only in so far as the interchanges are not sufficiently frequent to cope with the influx of fresh applied stress is there dissipation of energy. The insufficient rate of interchange results in certain molecules or molecular groups acting as dielectric molecules when they hold or trap parts of the applied stress and cause dissipation of energy in the electrolyte. The trapped energy accentuates the molecular motions and evidences itself as heat. Electrical energy is, of course, taken up in forming the new constituents of the electrolyte, but this is not energy dissipation.

In metallic conductors it is the minor electric systems in the ions, in other words, the atomic internal electric systems themselves, that are relatively unstable. For some reason the atomic fields of a metal are so constituted that electronic interchanges occur between neighbouring atoms. Each atom has, as it were, an outer range into which some electrons make excursions and returns. Those which make the more extensive excursions are liable to come into the range of neighbouring atomic fields when they exchange venue. Here, again, the interchange of electrons is normally chaotic, but becomes in some small degree organised under the influence of an impressed electric field and the "electronic drift" is produced. On the view here outlined metallic conductivity is determined by the rate of electronic interchange proper to the particular metal and the particular temperature. It does not assume that there are free electrons in the metal, only that the electrons become available in the act of interchange, and is closely akin to Sir J. J. Thomson's alternative theory of metallic conduction, which was framed to obviate the difficulty arising from a serious discrepancy between the free electron theory and the facts relating to the specific heats of metals. Obviously, also, the absence of any necessity for making the large assumption that numbers of free electrons float about between the atoms of conductors is, in itself, a strong point. The view here expressed, unlike Sir J. J. Thomson's, does not demand a pre-polarisation of the conducting molecules. It assumes that in the course of normal activity of the sub-atomic electrical systems, that is, the fundamental electrical systems in which the protons and electrons are directly concerned, a sufficient number of electronic exchanges are occurring in approximately the right direction to accord with the impressed electric force in the conductor, so that they are already amenable to its influence. In other words, a number of the atoms are already polarised in the direction required to meet the demands of the impressed force. That conductivity increases with fall of temperature in pure metals is accounted for on this view by the reasonable assumption that as the atoms pack slightly closer, more electron paths come within interfering range of neighbouring atomic fields and the rate of electronic interchange becomes greater. As in electrolytes the true conduction is effected without dissipation of energy. Resistance losses arise solely from the failure of the



electronic interchanges to take place at a sufficient rate to dispose of the impressed stress completely. The part of the stress not disposed of by handing on in the direction of wave propagation is partly absorbed by the conductor, producing accelerated molecular movement; and partly, again, emitted into the dielectric as a lateral field—that is, a field at right angles to the electric force in the wave proper. This lateral field corresponds entirely to the fall of potential along the conductor proportional to resistance.

From what has been said in reference to electronic drift and electronic interchanges, it might be inferred that the function is to hand on electric charges. In the author's opinion, this is a misleading, if not a wrong view. The function is to restore to normal the state of the molecular fields in the conductor after the handing on of the impressed electric force of the wave, and so put the molecular fields into a condition to conduct subsequent applications of impressed force. The assumption is that in conductors and dielectrics alike there exist available prepared stress paths for the transmission of wave fields. The interconnecting and changing electric fields of the molecules and atoms provide these paths. But whilst the disturbance of the molecular field arrangement following the passage of impressed stress corrects itself in conductors, it is not so in dielectrics. The electronic interchanges in conductors relieve the state of stress superposed on the molecular fields, and so, to some extent, prevent the setting up of a counter stress or opposing E.M.F. In dielectrics the counter stress set up balances the impressed stress and prevents further influx. The correction in conductors comes about by field re-adjustments made possible by the electronic interchanges.

In the diagram some attempt is made to convey a concrete idea of the kind of process which produces conduction in metals, by analogy with an electric circuit, in which rotating pairs of condensers, oppositely charged, take the place of atoms or molecules. If a sufficient number of the rotating pairs of condensers be connected in parallel, one or other will, at any instant, be in position to allow of the passage of a charge, and will have its normal charges restored immediately afterwards. The restoration of charges corresponds to the readjustment of molecular fields by electronic interchanges.

The molecular fields of conductors are self-restoring, those of dielectrics are not. This is the essential difference between the two. Wave conduction is equally present in both cases, but the conduction is transient in the dielectric because of the sustained opposing E.M.F. built up in it. The rapid decay of the opposing E.M.F. in conductors enables the conduction to appear as a continuous state.

In reality it is a very discontinuous state as referred to the separate molecules or small group of molecules of the conducting substance under a continuous electric stress. Such a group is essentially dielectric in its character, but exhibits conducting intervals when it may be said to be perfectly conducting, because there are no dissipation losses occurring during these spasms of conductivity. In this sense there may be said to be only rates, but no degrees of conductivity. The proper view of an imperfect conductor is that it is a dielectric to which is added the conductivity characteristic to a greater or less extent.

The slipping of electric waves along conductors by the interaction of molecular lines of force with the wave field must not be taken as implying that wave guidance by conductors is thereby brought about. With a perfect conductor the wave field would slip off at the first bend or curve. This would not be the case with an imperfect conductor, because the lateral electric field given out by the conductor produces a tilted resultant wave front. Applying Poynting's theory, which states that the direction of propagation is normal to the wave front, it follows that the wave propagation is diverted towards the conductor, the tilt being a forward one. This is, in the author's view, the effect which gives wave guidance in all its aspects, and without which there could be no currents in wires. It also indicates that the practical engineer would have little use for perfect conductors. This leads to the question as to why, then, are not luminous waves guided by conductors likewise? The answer appears to lie in the inertia of the electron. The change in direction of the wave field in a luminous wave is so excessively rapid that it is unable to exercise any control over the movements of the electrons during the electronic interchanges. For these waves there is no absorption of energy by the conductor, and hence no wave tilt. The full explanation, however, hardly concerns the present subject.

The extent of the wave tilt produced by resistance in broadcast transmission over the surface of the earth will vary chiefly with the distance from the source of oscillation, being very pronounced at short distances and becoming less as the annulus or ring of current at the surface expands outward until it is in general almost imperceptible at large distances, though never negligible. It will also vary with the local resistance of the ground over which the wave passes. This will have a corrugating or distorting effect upon the advancing annulus and wave front, because the horizontal component of the velocity of travel will be slightly decreased where extra tilt is given. On the other hand, there will be a slight increase of velocity at places where the tilt is decreased, as when a part of the wave front reaches the sea or ocean surface. The latter effect seems to be indicated under certain conditions of use of wireless direction-finding apparatus. Such distortions will also tend to produce positions of interference at places beyond the locality of distortion, owing to retardation of phase of parts of the wave front.

Major irregularities of surface contour doubtless also give rise to wave distortion and interference positions, not only because of the indentations in the wave front, but by reason of partial reflection of waves where sufficiently steep gradients of surface are encountered. In such cases a part of the wave is reflected and a part climbs over the surface. The latter part will have its velocity of travel up the gradient retarded to an extent depending on the increase of wave tilt relative to the gradient, and will reach localities beyond with a retarded phase producing interference with wave rays arriving by routes with different characteristics. This argument can be expressed in another way by considering an abrupt change of gradient or excrescence as intercepting the wave and producing an oscillating electric field which acts as a new wave source in much the same way as a wireless receiving antenna arrests a part of an oncoming wave, oscillates and gives out a new wave 180 deg. out of phase with the original and with the antenna as centre of wave propagation. Where the reflection is complete, any point in the shadow region beyond may be considered as subject to a force due to the original wave, and another equal and opposite force due to the secondary wave. Hence, there is complete annulment of the wave in that region and a true optical shadow is produced. But where the reflection is only partial, as is no doubt the case when surface excrescences are met, part of the wave climbs over and part sets up a new oscillating centre or wave source, giving out a secondary wave opposite in phase in the direction of propagation of the primary wave, and thus producing a degree of interference. This will not, however, result in a shadow in the optical sense, because the effect is quite local. The secondary wave produced will be rapidly diverging and therefore rapidly weakening, whilst the divergence of the primary wave will depend upon the distance from its source. In general, the original wave will speedily overpower the secondary wave as the obstacle is left behind.

The remainder of the paper deals with the essential differences between oscillations and waves, the reason why extra short waves are not subject to the same day-to-night variations as the longer waves, the reason why waves are unable to traverse the polar regions of the earth, and the sunset effect.

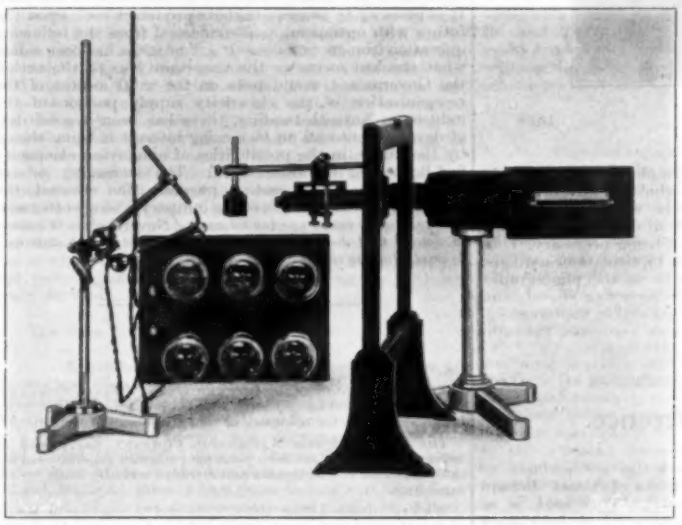
Broadly speaking, it is the author's view that it is to the interaction of electric fields and their manipulation that we must learn to look for accurate fundamental explanations rather than to motions of electric charges or electrons, and that it is necessary to bear in mind that such electric fields are never created or destroyed, either in material substances or in empty space. It is only the organisation in some small degree of pre-existing forces that is possible. In material substances concentrations

of these forces occur, but in empty space there are, apparently, no concentrations, and that is why it is suggested that the fundamental electric fields of empty space exist as closed electric lines of force. It is believed that a real insight into the mechanism of electric wave propagation is to be obtained only in this way.

The Protective Effect of Goggles.

In the course of a recent visit to the Sheffield district we had the curiosity to ask various steel makers as to their opinion of the utility and popularity of glass goggles for protecting their workers' eyes from the glare produced at very high temperatures, and we found that almost without exception glasses were not in favour. In these circumstances, and in view of the large number of men working on autogenous welding—one of the most trying occupations for the eyes—who ignore the merits of coloured glasses, it is noteworthy that we have just received a communication from J. and R. Fleming, Ltd., the opticians of 146, Clerkenwell-road, London, E.C. 1. This letter, together with our subsequent investigations at Messrs. Fleming's works, suggest that there is no real reason why protective glasses should be so unpopular, while their necessity needs no emphasis.

It is, of course, the ultra-violet rays which are most harmful to the eyes, although they are not normally visible, and goggles, to be of any real service, should cut off these rays without producing any material colour effect or reducing the clarity of vision. Glass makers have long known the means of producing a glass having the desired characteristics, but goggles made of such glass do not seem to appeal to general workers. The reason is, no doubt, that they have all the appearance of ordinary glass, and the average worker does not appreciate their merits as he does not so directly feel the effect of the ultra-violet rays as he does the glare of bright visible light. On the other hand, the blue glasses commonly used reduce glare very considerably, but do not necessarily provide any protection against ultra-violet rays.



APPARATUS FOR INVESTIGATING THE PROTECTIVE EFFECT OF GOGGLES

In view of these circumstances, Messrs. Fleming have constructed the apparatus shown in the accompanying engraving for investigating the protective effect of goggles. It comprises a spectroscope with a quartz optical system and an uranium glass screen, which makes the ultra-violet light visible through fluorescence. An arc lamp with unpurified iron electrodes is used as a source of light rich in ultra violet, and a screen of special glass is provided so that the operator can attend to the lamp without harm to his eyes. The bank of filament lamps shown in the illustration is used as a steadying resistance for the arc. The light from the arc lamp, after passing through a quartz condenser, is directed through the goggles under investigation, which are clipped on the rod projecting over the top of the instrument. The light then traverses the spectroscope and its intensity is measured on the fluorescent screen in hundredths of Angstrom units. On the right there is shown the infra-red end of the spectrum, towards the centre is the visible light, and on the left the harmful ultra-violet rays are indicated.

On experimenting with this apparatus, and trying a variety of different goggles, it was surprising to us to find the large extent to which some of them would pass ultra-violet light, although they were put forward as being protective, while they reduced very considerably the harmless illumination necessary for vision. On the other hand, there were several specimens which almost entirely cut off the ultra-violet without impairing visibility or producing a colour effect. One of the most interesting pairs of goggles was, however, a set, made for a special purpose, which cut off both ends of the spectrum, and left only the visible light. The ultra-violet was eliminated by a special type of glass, while the hot infra-red rays were reflected back by a very thin film of gold, so thin, in fact, that it readily passed the white light.

We understand that while Messrs. Fleming originally made the apparatus, we have described, for their own service, they are ready to supply sets to other investigators, and are willing to test goggles sent to them by users.

South African Engineering Notes.

Pig Iron Production.

It is probable that by the time these lines appear in print the first blast-furnace in South Africa to produce pig iron on a commercial scale will have been blown in. After considerable delay the blast-furnace, at the Newcastle Iron and Steel Works, in Natal, had at the beginning of February nearly reached production stage. Its erection was begun about five years ago, but it was not completed and the unfinished structure was acquired last year by the Union Steel Corporation of South Africa for the purpose of supplying the Vereeniging Steel Works of that undertaking with pig iron. It was expected that the production of pig would have been begun towards the end of last year, but the finishing touches to the furnace took longer than anticipated. However, at the beginning of February it was being tar coated, coke, ore and limestone were being accumulated, a new battery of boilers was being installed, and every effort was being made with a view to the blowing in of the furnace at an early date. For experimental purposes small blast-furnaces had been erected previously, and about 2000 tons of pig iron had been manufactured, but after it had been ascertained that the production of the metal was commercially possible, operations were stopped until capital could be obtained to erect a blast-furnace that would produce at a cost that would make the venture payable. It was not, however, until a few years back, when an Act was passed granting a bounty of 15s. per ton—gradually tapering away to nil—on pig iron produced from native iron ores, in quantities of not less than 50,000 tons per annum, that the Newcastle blast-furnace became an attractive proposition. The capital of the firm which had begun to erect it had come to an end just before the furnace was brought to the production stage, and the further sum necessary to complete it and start the manufacture of pig iron could not at the time be obtained. But the offer of the bounty and the fact that a further bounty of 15s. per ton was to be granted on iron and steel manufactured from that pig iron—provided the quantity produced was also 50,000 tons per annum—brought into the field the Union Steel Corporation, which is in urgent need of obtaining pig iron at a price substantially below that which overseas pig iron costs delivered in the Transvaal. The furnace is 70ft. high, and will have a capacity of 150 tons per day. There are three hot blast stoves and provision has been made for the erection of a fourth. The boiler plant is being substantially augmented—a "Bettington" boiler of improved pattern is being added to the boilers of the same type, which are already installed, and, in addition, a battery of Lancashire boilers is about completed. The "Bettington" boilers are to be fired with pulverised fuel, and the Lancashire boilers will be fired with ordinary coal at first, though waste gases from the blast-furnace will eventually be used for firing them. A new chimney stack has been erected to serve the additions to the boiler plant. The power plant consists of two Parsons steam turbo-generators for generating electricity, and the blast equipment is being supplied by two Allis Chalmers blowing engines—converted from air compressors—each of which will blow about 20,000 cubic feet of air per minute. The hematite ore which is to supply the Newcastle plant will be drawn from the farm Prestwick in the Dundee district, 59 miles from Newcastle along the railway line, and the limestone from the Taungs district.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

PETROL ENGINE CONVERSION.

Sir,—I should be glad to hear of the experiences of your readers who have used fuel oil as a substitute for petroleum in petrol motors. I should further like any general details which they may have of successful apparatus that may have been devised and actually used in connection with the conversion of internal combustion engines to run on fuel oil. The prohibitve price of gas in certain districts does not permit gas engines to be run at anything like a profit, so conversion to fuel oil is resorted to. It is possible to convert gas engines to run on lighter fuels, but this in almost every case, I believe, entails very large expenditure, since the compression ratio has to be altered, which involves special cylinder heads and pistons, &c. So we turn again to fuel oil, which, in my estimation, is a better fuel than paraffin, since it contains from 5 to 7 per cent. tar, which is in itself a lubricant. Where petrol engines have been run on paraffin, piston seizures, owing to paraffin dissolving the cylinder lubricating oil, seem common enough. Much time by many persons all the world over has been devoted to the subject of devising simple vaporisers for fulfilling the job, but I know of none that are really satisfactory.

It suggests itself to me that a new field would be open if experimenters and inventors alike realised the vast possibilities of fuel oil; after all, the loss of power would be very small on, say, a 220 brake horse-power petrol motor, possibly only 15 per cent., and comparing the cost of petrol in bulk at, say, 1s. per gallon, as against 6d. or even 4d. per gallon for fuel oil, I consider it well worth while.

PATRICK GAY.

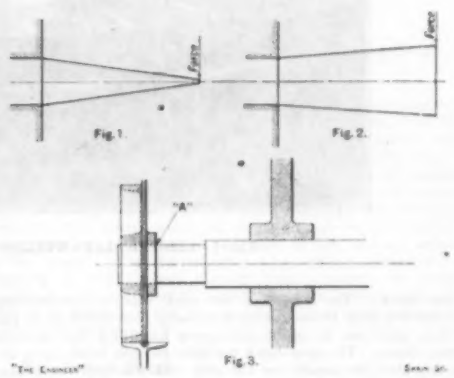
London, S.E., February 19th.

THE CHOICE OF STEELS FOR ENGINEERING WORK.

Sir,—A paper bearing the above title has been read before the North-Western Branch of the Institution of Mechanical Engineers by Mr. A. P. Hague. I trust we shall have the opportunity to read it in the technical Press at an early date, as it contained many points of great interest to the engineering profession.

Several points can with advantage also be debated in the technical Press, and I venture to commence with the criticism of sharp corners in shafts, &c. I am by no means a lover of sharp corners, but I object when these are getting the full blame for a breakdown when there are probably other causes of more importance.

During the discussion it was asked why a 2in. bar sawn quarter way through broke so much easier than a 1in. bar. This question seems to me very easy to answer, and although the sharp corner has some bad effect, the main reason is the much higher stress set up in the 2in. bar when hit with a hammer than that taking place in the 1in. bar. I will endeavour to explain the reason by another example. Assuming two bars—as shown in Figs. 1 and 2—made from circular material and tapering towards the free end being hit with a hammer at the end. The bar—Fig. 1—will deflect several times more than the bar—Fig. 2—and as the energy put into the hammer head is the same, and this has to be absorbed in work done in bending the bar, it follows that the maximum force resisting the blow is higher for Fig. 2 than for Fig. 1. Therefore the stress in bar, Fig. 2, is much



higher than that in Fig. 1. Actual figures can be worked out by means of the deflection curve. In this case, at any rate, there is no weakness due to any sharp corners.

Referring again to the notched 2in. bar, it is obvious that when the end of the bar is hit with a hammer, the end of the bar must deflect, and as the bar between the notch and the end is very stiff, the deflection at the end will be very small, and the maximum force resisting the blow very high. This maximum force will throw a big strain on the reduced area of the bar.

Again assuming a tram axle, as shown in Fig. 3, I doubt if the sharp corner at A is as bad as was made out in the paper—certainly it is not a good point. When a tram turns a corner and the wheel strikes the side of the rail, the energy in the tram will have to be absorbed by deflection in springs, tram rails, axles, &c., and as the axle between the bearings is not reduced in diameter, but is actually made stiffer by the boss of the gear wheel, the effect would be a high stress at point A.

A similar case is an overhung crank on a steam engine, where the part of the shaft carrying the fly-wheel is made very stiff. If the engine is started up with water in the cylinder, part of the energy of the fly-wheel will have to be absorbed in bending the shaft, a surface crack may develop which will eventually go practically through, and we are told that the shaft is broken due to fatigue, which is not the case.

It is quite evident from the above that the stress in material is dependent on the quality of the material, and designers are liable to overlook this fact, as they are so used to considering all forces as static forces only.

I should like to know what relation, if any, is found to exist between the modulus of elasticity and the figures obtained from a notch bar test.

Looking forward to remarks from your readers on this matter.

T. MORS.

Manchester, February 19th.

FOREIGN TOOL STEEL.

Sir,—Some firms may not have seen in the past letters and articles appearing in the daily Press and certain trade papers, referring to tool steel and other commodities of foreign manufacture which foreigners are trying to sell to British buyers. I recently had an experience of such a case, when two foreigners, of different nationality, called on me and tried their hardest to persuade me to take a trial lot of tool steel.

These people were anxious for me to give them such an order on this basis while they waited, as they were desirous of showing to other firms they were calling on that day that they had been successful in obtaining permission to supply my firm with a trial quantity. The quantities that they wished me to sign for were such that the invoice would have come to the sum of nearly £120.

The steel was said to be a mixture, and the representatives stated that they had a patent in this country, though I understand that patents for mixtures are not procurable in England.

There is no doubt that great care has to be taken when such people call upon English firms. I should be pleased to hear if any of your readers have had a similar experience.

February 22nd. SAFETY FIRST.

Electrically Welded Gasworks Structures.

THE first gasholder to be constructed throughout by electric welding was, we believe, that which was built at Melbourne in 1922. Considerable progress in the application of welding to steel construction has been made since that time. At Fitzroy the erection of a 1,000,000 cubic foot gasholder is now proceeding. Fig. 1 shows the completed tank, which measures 102ft. in diameter, is 18ft. in depth, and comprises four belts of plating $^{7}/_{16}$in. to

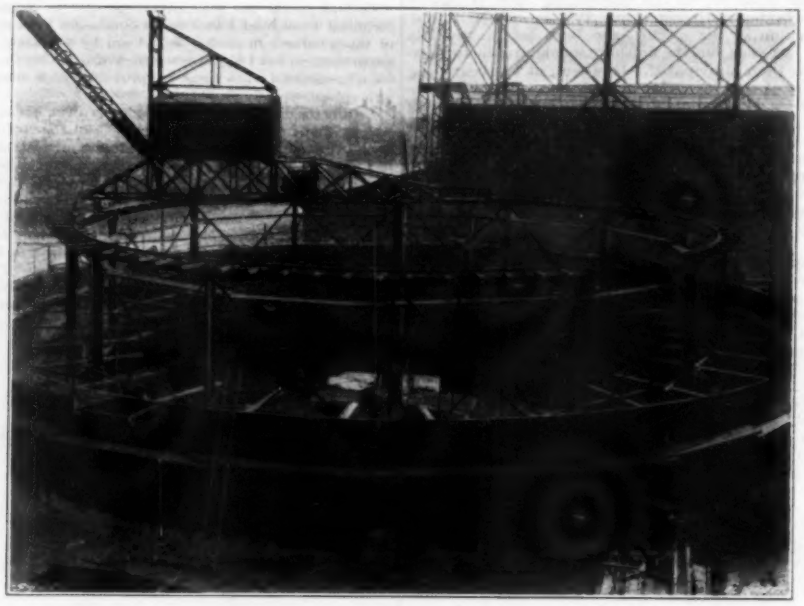


FIG. 1—ELECTRICALLY-WELDED GASHOLDER UNDER CONSTRUCTION

$\frac{1}{2}$in. thick. The whole of the tank was, we understand, welded within three weeks, with only four welders on part time, and six to eight labourers handling the material and crane. The new tank fits into the old brick tank of a gasholder previously on the site. It was built at ground level, and was lowered by eight screw jacks as each belt was completed.

The most notable features of this work are, first, the fact that it was not found necessary to drill or punch a single hole for the manufacture or erection of the tank or its fittings, and secondly, that the edges of the plates were used as cut by the shears. The joints, both vertical and circumferential, are lapped and welded inside and out, and the tank as built is truly cylindrical.

Service pieces for supporting the plates in position, and for wedging them closely for welding, were cut from scrap material and temporarily welded to the plates, being cut off later and used elsewhere as the work progressed. For closing the vertical seams a large light clamp, similar to a portable hydraulic riveter, was built. This apparatus had grooved wheels at the top, which ran on the top edge of the plate, and it could be easily moved by hand from plate to plate. It had a 5ft. opening, and $\frac{3}{4}$in. screws were arranged at intervals of 6in. to engage and close the plates until they were tack welded.

The crane employed is also of welded construction, and its jib can be extended to 100ft. in length. This crane was built for the erection of a 2,750,000 cubic foot gasholder, which is seen in the background in Fig. 1, and which was also completely welded electrically. It weighed, including the structural steel work in which there was not a single rivet employed, upwards of 750 tons. The temporary structures for the crane, including the central steel plate column and bracings, were also welded, and the material when the work is completed will be returned to stock.

The gasholders referred to were designed by Mr. J. Newell Reeson, M. Inst. C.E., engineer-in-chief of the Metropolitan Gas Company, Melbourne, and the whole of the work, including that on the crane, was carried out by the company's own workmen.

Another example of rivetless construction which was carried out by the workmen of the same gas company is illustrated in Fig. 2. The water lute purifier covers shown are 25ft. square by 3ft. depth at the sides. The sides are of $\frac{1}{4}$in. plates and the tops $^{3}/_{16}$in. with curb angles 4in. by 3in. by $\frac{1}{2}$in. The top framing consists of 12in. by 5in. R.S. joists with $\frac{1}{4}$in. plates welded to each side, and these are welded to the curb angles. The cleats, which are seen at various points along the sides, are for holding down bolts and the lifting gear. They also were welded on. In this construction it was not necessary to drill a single hole for service bolts for assembly, nor to employ a fire or a blacksmith on any part of the job, the whole of the work being tacked in position and completely welded electrically. The material was used as it came from stock, no machining of the edges or special preparation being necessary.

The Quasi-Arc Company, Ltd., of 15, Grosvenor-gardens, London, S.W. 1, which has sent to us the photographs from which our illustrations have been reproduced, and supplied us with the particulars contained in the foregoing, informs us that Quasi-Arc electrodes were used throughout for both works.

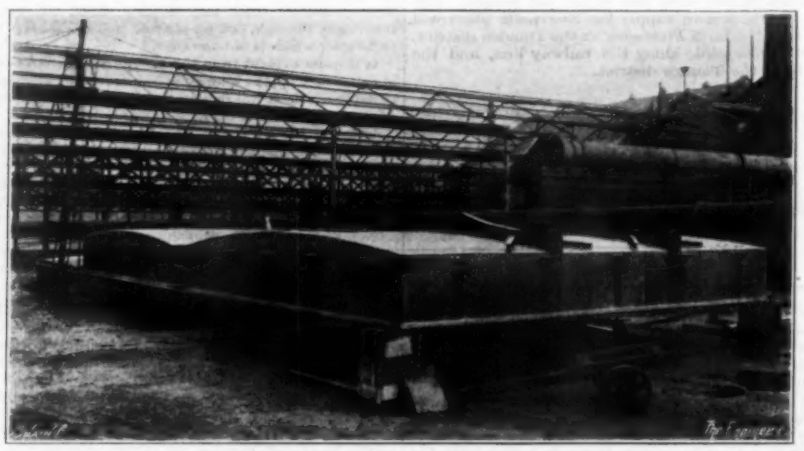


FIG. 2—ELECTRICALLY-WELDED WATER-LUTE PURIFIER COVERS

Books of Reference.

THE forty-second annual issue of the "Year-book of the Scientific and Learned Societies of Great Britain and Ireland" has just been issued.—This book is so well known that it really requires no word of description from us, but we may say that, in addition to giving the names and addresses of a very large number of societies and institutions, together with a list of its officers and particulars as to membership, meetings, &c., it also provides complete lists of the papers read before, or, in some cases, of publications issued by the different bodies during the session 1924–1925, so that it really forms a record of the work done in science, literature, and art during that period. It is published by Charles Griffin and Co., Ltd., 42, Drury-lane, London, W.C. 2, price 15s.

Directory of Shipowners, Shipbuilders and Marine Engineers, 1926. The Directory Publishing Company, Ltd., 33, Tothill-street, Westminster, London, S.W. 1. Price 20s. net.—We have to hand the twenty-fourth edition of this useful volume, which for the second year appears, by request, at the beginning of the calendar year. In its general scope and size the volume remains unaltered, but some additions have been made to the text. In the first section, information regarding the Admiralty and Government Departments, along with particulars of the British and Foreign Classification Societies, is given. Thereafter follows the Shipowner's Section of 459 pages, along with information concerning shipbuilders, ship repairers and marine engineers, which occupies 108 pages. The remainder of the book is taken up by a list of consulting marine engineers and naval architects, along with a directory of trade and technical associations and institutions, and the very complete index which contains under its four sections about 22,000 entries. The directory is so well known that further comment is unnecessary.

THE 1926 edition of "Who's Who in Architecture," which is published by the Architectural Press, 9, Queen-Anne's-Gate, London, S.W. 1, price 25s., has been expressly timed to coincide with the recently concluded amalgamation of the Society of Architects and the Royal Institute of British Architects, and the new volume includes the numerous qualification changes which that event has brought about. The book, in addition to giving over 300 pages of biographical notices of British architects, also contains information concerning a large number of schools of architecture, as well as short references to societies and institutions the interests of which are akin to those of the architect.

THE 1926 issue of "'The Electrician' Directory and Hand-book of the Electrical Engineering and Allied Trades"—or as it is so often called "The Big Blue Book," is the forty-fourth edition of this exceedingly useful work of reference. It is published by Benn Brothers, Ltd., 8, Bouverie-street, London, E.C. 4, price 25s.—Outwardly the present volume does not differ at all from those which have gone before it, but we are assured in the preface that all parts of its contents have undergone careful revision, and, indeed, from those portions which we have had occasion to consult we can testify that that revision has taken place. We have little doubt, therefore, that it will be found as helpful as its forerunners have been in the past. It is pleasing to observe that its producers look upon the future with optimism, as is evidenced from the following quotation from its preface:—"... progress has been somewhat checked owing to the uncertainty as to the action the Government would take on the vital matter of the reorganisation of the electricity supply portion of the industry. Notwithstanding, there has been a good deal of development and an increasing interest is being shown by the public in the possibilities of employing electricity for lightening domestic work. The increasing sale of apparatus for broad-casting purposes has assisted the prosperity of that branch of the industry, though otherwise outstanding events are far to seek. Nevertheless *it cannot be denied that the electrical industry is in a sound state and is ready for big things.*" The italics are ours.

CONTRACTS.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., has received an order for twenty-five complete sets of air brake apparatus for tramcars of the Edinburgh Corporation.

THE ORIENT STEAM NAVIGATION COMPANY has placed an order with Vickers Ltd. for a passenger steamer generally similar in dimensions to the Orama and Otranto recently built by the same firm.

WE are informed that Alfred Holt and Co., acting on behalf of the Straits Steamship Company, Ltd., have placed an order with Vickers Ltd., Barrow-in-Furness, for a fast turbine-driven twin-screw passenger vessel for service between Singapore and Penang.

THE RANSOME MACHINERY COMPANY (1920), Ltd., of Windsor House, 46, Victoria-street, London, S.W. 1, has received an order from Sir Robert McAlpine and Sons for four of its "Welterweight" concrete mixers, which each have an unmixed batch capacity of 12 cubic feet.

WE are informed by the Air Survey Company, Ltd., 3, Copthall-buildings, Copthall-avenue, London, E.C. 2, that Mr. Ronald Kemp, its managing director, has recently secured a contract for aerial survey work from the Government of the Federated Malay States. This work will follow the completion of a contract with the Sarawak Government, which is just about to commence.

THE MIRRLEES WATSON COMPANY, Ltd., of Scotland-street, Glasgow, has secured, against severe continental competition, an order for a sextuple effect distilling plant for Jeddah. The plant is to be capable of producing 150 tons of fresh water from sea water per twenty-four hours and is to be complete with the necessary boilers and pumps. It is the second installation for the port of Jeddah and is the fourteenth set supplied by the firm to various places on the coasts of the Red Sea.

THE COMPANIA HISPANO-AMERICANA DE ELECTRICIDAD has contracted with the International General Electric Company for two 52,500-kilowatt tandem compound steam turbine generators as the initial installation for the new generating station to be built at the entrance of the harbour of Buenos Aires. Each generator will be a 50,000-kilowatt, 13,200-volt, 1500 revolutions per minute main unit with a 250-volt direct-current exciter and a 2500-kilowatt, 2300-volt service generator with its own direct-current exciter, all mounted on the same shaft. The turbines will operate at an initial steam pressure of 550 lb. gauge and 750 deg. Fah. total temperature, with full intermediate reheat of the steam between the cylinders.

MESSRS. F. TURNBULL AND CO., of Heaton Junction Works, Newcastle-on-Tyne, have received orders for the coal loading plants required in the dock extensions at Ellesmere Port on the Manchester Ship Canal and at the Lonsdale Dock, Workington Harbour. The Ellesmere Port plant comprises the latest type of india-rubber and canvas belt conveyor, loading bridges, cranes and machinery, and will be capable of shipping 1000 tons of coal per hour. It is to be capable of delivering coal to any part of a ship over a range of 260ft., a breadth of over 60ft., and a height of 50ft. Mr. H. A. Reed, M. Inst. C.E., the Manchester Ship Canal Company's chief engineer, is responsible for the design of the plant. In the Workington Harbour plant facility for moving the loading spout to any part of the ship is to be a distinguishing feature, whilst the question of preserving the coal from breakage during the process of loading has received close attention, the most recent type of Handcock "anti-breaker" having been adopted. Messrs. Rendel, Palmer and Tritton, consulting engineers, of Westminster, have prepared the drawings and will supervise its construction.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Ironmaking Pre-eminence of Staffordshire.

THE proudest boast of the Staffordshire district is its pre-eminence the kingdom over as a manufactured iron producer. Times without number has it been prophesied that the Birmingham and South Staffordshire centre has "seen its last" as an industrial district of any great importance, since its producers adhered to the manufacture of rolled iron rather than take on the once new industry of steel making. The falsity of the prediction has been proved with the years. The prosperity of South Staffordshire continues, and we still boast the distinction of being the largest makers of rolled iron of any of the iron and steel districts of the country, Scotland not excepted. Beginning with Bessemer in 1856 and succeeded by Siemens and by the two Martins in 1864, and later when we come to the period of the basic and basic-Bessemer processes by Thomas, Gilchrist, F. W. Harbord and others, the brilliant line of steel inventors of the later half of the nineteenth century never had very special terrors for the historic firms in the Staffordshire iron trade. Rolled iron of magnificent quality in the form of boiler-plates, sheets, bars, hoops, &c., branded and known as "Staffordshire marked iron" had a reputation the world over for its wonderful fibre and unequalled toughness very long before Bessemer startled trade and industry by his great discovery. Granted this quality of Staffordshire iron is now made in only small tonnage, but merchant qualities, the product of the puddling furnace, continue to be turned out in large quantities. Last week the local technical body, known as the Staffordshire Iron and Steel Institute, entered a fine claim for the superiority of wrought iron compared with steel, and I may say that in so doing the Institute has once again greatly pleased the bulk of the trade. That the majority of the Institute should have been clearly in favour of the older product is, I may say in passing, only a repetition of repeated former declarations by the same most capable authority. Mr. G. T. Astbury, of the Netherton Ironworks, who opened the discussion, argued that in many cases where steel was used iron would give better service, and that many of the properties of wrought iron were not sufficiently recognised and utilised by engineers. He gave instances seeking to show the greater power of resistance in wrought iron to corrosion, shock and fatigue. On the question of corrosion the balance of evidence was distinctly in favour of wrought iron. The rate of corrosion of steel tubing, for example, was 50 per cent. higher than that of wrought iron, an understatement of the case when the tubes were actually under working conditions. Mr. J. Raybould—Pensnett—was a whole-hearted supporter of iron for its durability, and gave instances of iron boilers having stood forty years' service.

The Case for Steel.

Of course puddled iron is not allowed to have all its own way even in Staffordshire. Steel has its adherents and naturally enough they championed their metal before the Institute on the occasion I am speaking about. Mr. T. W. Ellett, of Smethwick, near Birmingham, held that steel would ultimately displace iron. The development of the steel trade in the last forty years had been prodigious, while advance in iron manufacture had been practically nil. "Unless some development," said Mr. Ellett, "such as the use of liquid metal from the blast-furnace, or the introduction of mechanical methods of wrought iron making is soon forthcoming, nothing will save the iron trade." Wherein, inquired this member of the Institute lay the superiority of good Staffordshire iron compared with a good steel? The strength and ductility of iron varied with the amount of work put upon it. Small sizes compared very well with soft steels, as regarded tensile elongation and reduction of area, but large sizes of iron often suffered from lack of "work" in the making, and their physical properties fell. Mr. W. H. Stone—Wolverhampton—favoured steel, because the output was higher and more uniform, and the costs lower.

A Warning to Ironmasters.

Wonderfully good as the bulk of Staffordshire rolled iron undoubtedly is, it would seem that there is need for new care if its historic reputation is to be maintained. Mr. G. T. Astbury declares that one result of the excessive Belgian iron competition at the present time is that some of the local makers of common bar and other iron are succumbing to the temptation of following Belgian methods of manufacture. Belgian iron was, he said, really 100 per cent. steel, being made out of layers of steel scrap. "There are British ironmasters who are following the same suicidal policy," declared Mr. Astbury. "They are deliberately putting steel scrap into piles to the extent, in many cases, of 80 per cent. But they make the top and bottom bars of wrought iron. That is the way to ruin the iron trade." His own firm was endeavouring so to educate the consumer of iron that he simply would not be put off with mixtures when he expected to receive the genuine article. The remedy lay in the hands of the buyer and his inspecting engineer.

Faith in Staffordshire's Future.

Mr. Geo. Hatton, managing director of the Earl of Dudley's Round Oak Iron and Steel Works, at the annual dinner of the Institute, sounded a note of optimism as to the future of the Staffordshire iron and steel industries. He asserted that the decline in the iron trade of the district was not due to neglect of opportunities or lack of enterprise on the part of its manufacturers, but to the force of circumstances, particularly the substitution of steel for iron. He believed that South Staffordshire would still retain a considerable hold on the iron trade and on many of the sectional trades which supported it. It was a matter for congratulation that the chain, cable and anchor trades of the district remained, with activities almost as great as ever, and he believed that they would continue to survive the competition of other districts. Mr. Cyril Lloyd was also optimistic. In industry, he said, South Staffordshire was not going to be a back number; it would gradually win through to a more prosperous condition. "I ask you," said Mr. Lloyd, "not to loose heart, but to stick to your tasks and spread the spirit of conciliation. These things, coupled with real progress and hard work will, I am sure, enable members of the Staffordshire Iron and Steel Institute a hundred years hence to look back upon 1926, not only as a period when the trade of the district was about at the bottom of the hill, but the point from which a great era of industrial prosperity commenced."

Finished Iron.

Demand for finished iron from the Staffordshire works shows a slight improvement. Best bar makers have orders in hand which insure steady running of the mills for the time being. A few fairly substantial sales of Crown bars have been effected. Nevertheless, faith in the stability of trade is fluctuating. Industrialists who can see as far ahead as April count themselves fortunate. While the price of marked bars is maintained at £14 per ton that of Crown and nut and bolt qualities have weakened slightly. There are works in this district which have this week reduced their quotation for Crown bars 5s. per ton, asking £11 5s. as against last week's figure of £11 10s. Buyers lead one to believe that £11 would not be refused for a good specification. Some sellers of nut and bolt iron are also stated to be accepting £10 5s., or 5s. less than the generally quoted price. The restart of the works at Charleroi has enabled much prompter shipments to be made of nut and bolt iron, delivered here at £6 15s., considerably more than £3 below the Staffordshire price of iron used for similar purposes, although it is well understood that there is no comparison in quality. There are still works in the Darlaston district making nuts and bolts from iron, in spite of the great disparity in price. A good deal of business is captured by the re-rollers of steel in competition with the large steel works, through the ability to utilise foreign billets. It is, however, less easy to get quotations for these from the Continent, and an inquiry for 500 tons of 2in. and 2¼in. billets which has been circulating for some weeks has failed to get a response. The January imports indicate that large quantities are still coming in on old contracts.

Steel.

Demand for steel is just about maintained on the recent level, but the obscure outlook is to some extent holding up constructional projects. Among the favourable indications is the doubling of contracts by some railways, and a marked activity in buying on the part of country warehousemen and the representatives of building interests. Some of these buyers have shown keenness lately, with the result that improving orders have been placed both for iron and steel with Staffordshire works. The recent orders for shipbuilding promise more business to the plate mills. The total quantity, however, is comparatively insignificant, compared with the capacity of modern mills. The lack of expansion of business no doubt accounts for the failure of the efforts recently made to place steel prices on a better basis. There are too many producers sorely in need of business to avert the closing down of more plant for buyers to be seriously disturbed by the repeated threats of advances. However, in the structural branch values have hardened slightly, the minimum for ship, bridge and tank plates having advanced to £7 17s. 6d. Angles and joists may be obtained at £7 2s. 6d. upwards, and tees at £8 2s. 6d. Small bars can be bought at £7 17s. 6d. Boiler-plates command £11 upwards, and Staffordshire hoops are £10 10s. at works. The market has weakened so far as continental material is concerned, and Belgian billets have been sold at well under £5 10s. Native billets continue to be quoted £6 2s. 6d. upwards. The very low prices for joists, bars, &c., of foreign origin which have prevailed for some months past, are still being quoted; joists, for example, being obtainable at £6 5s. delivered here, about £1 below the British product. Steel bars at £5 6s. Antwerp are formidable competitors, and are being largely bought by warehousemen and others. Steep scrap is a slow market at £3 7s. 6d. to £3 10s.

Pig Iron.

Business in Midland brands of pig iron is decidedly quiet, but furnace fuel being inclined to firmness helps to maintain the selling figure of No. 3 Northampton at £3 4s. 6d. to £3 5s., and Derbyshire £3 7s. to £3 7s. 6d. Makers are, however, careful not to commit themselves, and offers of substantial contracts are not accepted. Hand-to-mouth buyers of pig iron unsuccessfully try to shake the resolution of sellers in maintaining the recent advance in prices. Those who can afford to wait believe they will meet with more success when present contracts run out. Meanwhile they are content to take their chance. Bids for forward supplies at less than the current rates are not entertained by Midland blast-furnacemen. The strict relation which has been maintained between output and consumption is another steadying factor in regard to values. Forge pig is very firm, in spite of the paucity of demand. Furnacemen continue to quote on the basis of £2 17s. 6d. f.o.t. for Northamptonshire forge. There was little activity in Derbyshire forge, which is quoted £3 2s. to £3 3s. Until there is more certainty in the outlook, particularly in regard to coke supplies and prices, it is doubtful if there will be any re kindling of furnaces in this district, which have long been idle.

Galvanised Sheets.

The galvanised sheet trade has become rather firmer, recent bookings at the reduced price of £16 having improved the mill position, and a premium is now asked on forward contracts. Inquiry for galvanised corrugated sheets of 24-gauge shows improvement, both on home and export account, and on 'Change in Birmingham to-day the commonly quoted prices were from £16 to £16 5s.

Unemployment.

A still further decrease in the number of unemployed in the Midlands area is shown by the latest returns. The total of wholly unemployed is given as 123,244, as compared with 126,516 for the previous week, a decrease of 3272; and the number on short time or temporarily employed as 37,652, as compared with 39,798, a decrease of 2146.

A Gathering of Agents and Travellers.

An interesting gathering took place at the Wellington Tube Works, Ltd., Great Bridge, Staffordshire, on Friday, February 19th, 1926, when the agents and travellers of the company from all parts of the country assembled in Birmingham and were conveyed to the works by motor car. The morning was spent in a tour of inspection, which proved most attractive, especially the new Buttweld Mill, which is claimed to be the most up-to-date of its kind in the country. The party on its return to Birmingham was entertained to luncheon at the Queen's Hotel, and in the afternoon a conference was held at which the chairman of the company, Mr. Douglas W. Turner, presided. In welcoming those assembled, he pointed out that the gathering was the first of its kind since the inception of the firm in 1872. A vote of thanks to the chairman for presiding was proposed by Mr. W. Jones, of the Eastern Counties, seconded by Mr. Parkes, of London, and carried with acclamation. The chairman, in returning thanks, expressed his opinion that the meeting would be beneficial to all concerned.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

General Outlook.

LITTLE or no improvement in the Lancashire iron and steel markets can be recorded this week, and the tone in most instances on 'Change has been rather depressed. Certainly, those pessimistically inclined easily outnumber those who have anything cheerful to say about the condition of things. A fair amount of constructional work is going on in Manchester and the surrounding districts, and many more big schemes are in contemplation, but their influence on the tone of the market seems to be small. The Lancashire engineering industry is showing a slight, but steady improvement in some branches, but apparently something more pronounced is needed to influence the movement of iron and steel in a favourable direction.

Non-ferrous Metals.

The market for the non-ferrous metals is flat, and after the buying that took place last month there has been a notable lull which continues at the present time. Copper keeps steady, but buyers seem very reluctant to enter the market for any important quantities. The Americans, of course, are said to be contemplating dealing with this metal in much the same way as this country is alleged to have done with rubber, but whether anything will result from the reported intention to push prices up remains to be seen. They did succeed in raising values by about £2 per ton, but the price has since dropped by £1. The galvanising trades have been busy, and have been absorbing fairly substantial quantities of spelter, but the demand is not now so pressing and prices seem to be weak. There is no shortage of the metal, and in this case also a great deal depends upon the policy which American producers may adopt. There is known to be a surplus of spelter in the United States, and if the price were reduced there the British market would very soon be affected. American values lately have been about £2 per ton higher than continental prices. Lead is not attracting very much attention at the moment, and it will need a resumption of activity in the cable-making industry to stir things up here. There is a fair business being put through in tin. Prices of this metal are very high, and it is regarded on this market as not unlikely that the price of £300 per ton will be touched before long, particularly if, as is expected, a further reduction in stocks is reported this month.

Iron.

The iron market is very dull at the moment, and buyers seem extremely reluctant to do anything more than buy for early delivery, and then only on a comparatively small scale. Apart from the general industrial conditions, the coal trade uncertainty is clouding the outlook so far as forward buying is concerned. Another factor which is put forward in explanation of the present lull in buying operations is that a good deal of business was booked in the closing quarter of last year. Prospects for the immediate and early future, so far as this area is concerned, are not regarded too hopefully at the moment. Quotations for foundry iron, however, keep steady in most lines. Derbyshire No. 3 foundry pig is maintained at 76s. per ton delivered, a figure which applies also to Staffordshire and Lincolnshire makes. Scottish pig iron is between 95s. and 96s. per ton delivered, while West Coast hematite is being quoted at 92s. delivered in Manchester, and East Coast at 78s. on rails. Bar iron is selling in very small quantities, and very little of the business that is going through is on forward account. Lancashire Crown bars are offered at £11 10s. delivered Lancashire, with seconds quoted at round £10 5s. per ton.

Steel.

The demand for steel is also very restricted at the moment, and so far as the next month or two is concerned, it is believed that we are in for a rather quiet time. Most of the inquiry is restricted to prompt requirements, and only a very limited demand has come on the market for contract deliveries. For delivery into the Manchester area, about £7 per ton is quoted this week for angles and joists, with small bars on offer at £7 15s. to £8

per ton, including delivery. Plates are quiet and have an easy tendency, £7 12s. 6d. per ton having been quoted, while for boiler plates about £11 5s. per ton has been asked. These rates also include delivery into the Manchester district. Billets are attracting comparatively little attention, though prices are steady at £6 5s. to £6 10s. per ton delivered. Continental semi and finished steels are offered here at competitive figures, the prices, including delivery in Manchester, being about 20s. per ton less than can be quoted by British makers. The lower prices, however, do not appear to be a sufficient inducement to buyers, for business is on a small scale.

Scrap.

Notwithstanding the absence of any important buying, values of the scrap metals, particularly the non-ferrous, are steady, though in the case of iron and steel there is some weakness, ample supplies being available. Mild steel scrap is offered at round 55s. per ton on trucks in Manchester; wrought iron is quoted at about 70s. per ton; whilst cast iron scrap, ordinary machinery quality, and textile machinery scrap are at 70s. to 72s. 6d. and 75s. to 77s. 6d. per ton respectively, delivered to buyers' works. Non-ferrous scrap, graded, sorted and delivered, is £33; lead and aluminium, £90; best selected gun-metal, £54; and heavy copper, £60 to £62 per ton.

Manchester Ship Canal.

The report of the directors of the Manchester Ship Canal for the year 1925 states that the sea-borne traffic amounted to 5,622,405 tons and barge traffic to 259,286 tons, total 5,881,691 tons, which constitutes a record year's working; while the receipts amounted to £1,493,544. The report states that the construction of the superstructure of the two reinforced concrete transit sheds on the north side of Dock No. 9 is making satisfactory progress; that additional railway accommodation has been provided at Salford, Eccles and Ellesmere Port; and that work has continued on the provision of road and railway facilities for the development of the company's extended dock estate at Stretford and Barton. It is also reported that the deepening of the canal to 30ft. between Eastham, Ellesmere Port and Stanlow oil dock is nearing completion, and satisfactory progress is being made with the provision of the additional depth in the Eastham approach channel. In order to facilitate the passing of large vessels in the canal, lay-byes are being constructed at Stanlow and Moore. The lay-bye at Stanlow will also be available for the discharge of petroleum products with a flash-point not below 73 deg. Fah., and other merchandise. Contracts have been let for the extension of the northerly quay of Ellesmere Port docks, for a length of 1200ft., by the construction of a reinforced concrete wharf and for coal-handling plant and ancillary works.

Institution of Mechanical Engineers.

At a meeting of the North-Western Branch of the Institution of Mechanical Engineers, held at Manchester on Thursday, February 18th, Mr. A. P. Hague (Sheffield) read a paper on "The Choice of Steel for General Purposes." He pointed out the need in selecting a steel of giving careful consideration to the conditions under which it was to be employed, in particular to the type of stress to which it was to be subjected. With the knowledge of these conditions available it was possible to state the physical properties which were required in the chosen material. Mr. Hague then proceeded to discuss the various known methods of testing, and demonstrated that the tensile test had certain failings when applied to alloy steels. He said that the elastic limit and yield point were of little use, but that the ultimate strength and reduction of area gave valuable data. The Wöhler rotating bending test gave a useful indication of the elastic range, and for most steels the safe range and ultimate tensile stress were in close agreement. The notched bar test was, said the author, useful to indicate the resistance of a material to the propagation of a crack, in which case it was apparent that steel with a very low notched bar value was likely to be broken into pieces under heavy shocks. The materials available, with their useful properties and drawbacks, were next considered, in particular carbon, nickel and nickel-chrome steels. Their values for structural purposes were compared, as well as the effect of dimensions upon their tested properties. Case-hardening, acid and basic steels and steels which resist heat and corrosion were considered, and forged and rolled steels were compared. Perhaps the most instructive part of the paper was that devoted to typical failures and fractures of steel in service, of which the author gave numerous excellent photographic representations on the screen. The author said that, generally speaking, where soft steels were subjected to static loading, basic material was satisfactory, but for those steels which normally were hardened and tempered as well as those which were to be subjected to dynamic stress, acid material was superior on account of the absence of non-metallic inclusions.

BARROW-IN-FURNESS.

Hematite.

For some reason or another, the West Coast hematite pig iron trade is dragging. It might be argued that this is due to the uncertainty of the outcome of the coal inquiry, but against that theory there is the evidence of improvement on the East Coast. Business certainly is on the quiet side at present, and customers are only inclined to place orders for immediate delivery. With the improved outlook in the shipbuilding and engineering trades, it is possible that business may improve when specifications are out. The local steel departments are taking a fair amount of iron, otherwise there would be more pig iron going into stocks than there is at the present time. The Midlands continue to be the best customers. Scotland does not bulk largely at present, but there is a chance of improvement. Continental trade is slack, but business with America continues to a certain extent.

Iron Ore.

The iron ore trade is only moderately employed, and there is not much going out of the district. None of the mines are what might be called briskly occupied, and some are actually quiet. Foreign ore is coming in in restricted tonnage from Spain, Norway, &c.

Steel.

There is nothing fresh to report as regards the steel trade, and the two works at Workington and Barrow are still operating. At the Workington rail mills there is not work for the full month, but at Barrow the mills are going all the time, though fresh orders are needed to keep them going. The hoop and small section departments are better circumstanced.

Shipbuilding and Engineering.

Vickers obtained two orders last week-end which are very welcome. It is a compliment to the firm to receive an order from the Orient Line for a third 20,000-ton Australian passenger ship. The two liners which the firm has already delivered, the Orama and the Otranto, have given every satisfaction, and the latter is not only to be used on the Australian service, but is to be engaged on Mediterranean and Norwegian tours. The new vessel will be 658ft. long, with a beam of 75ft., and her two sets of turbines will have a total horse-power of 20,000. She will carry 600 first-class passengers and 1200 third-class passengers. The other steamer, ordered by Messrs. Alfred Holt, on behalf of the Straits Steamship Company, is intended for service between the Straits Settlements and Penang. She will be a twin-screw vessel and will have a fair turn of speed. Her dimensions have not been made public yet.

SHEFFIELD.

(From our own Correspondent.)

The Heavy Steel Trade.

IN spite of the signs of trade improvement in various parts of the country, where the engineering works are reported to be growing busier, there is little or no advance to record in the state of the heavy steel trades of this district. The figures of production for last year show at least 25 per cent. of the smelting capacity was idle throughout the period. The total output just exceeded a million tons, which was practically the same as in 1924. It was a great deal more than in 1913, but the increase did not by any means correspond with the increase in capacity. At present, the open-hearth furnaces in the district are producing rather more than the average of last year, but there is no certainty of this level being maintained. The number of large contracts being placed is very small. One large firm, outside the city, had to take the step of suspending a number of hands last week. There has lately been a fall in the prices of the lower grades of rolled steel, in consequence of severe competition, especially in the export markets; and pig iron, after a revival of activity in January, is quiet again.

North Lincolnshire Extensions.

A list of Treasury guarantees under the Trade Facilities Acts, published last week, included the sum of £650,000 for additional plant and machinery for the Appleby Iron Company, Ltd., of Scunthorpe. This company is one of the units of the United Steel Companies, the headquarters of which are at Sheffield. Great extensions were made during the war, when the company, which originally was a producer of pig iron, installed blast-furnaces, Siemens steel furnaces, and modern rolling mills, at the request of the Government, about £3,000,000 being spent. The Armistice, followed by the great trade slump, brought the scheme of extensions to a standstill, but it is now to be resumed. In the latter part of last year the United Steel Companies decided, in view of the trade outlook, that the time was opportune for proceeding with the work, and the chairman stated at the annual meeting that arrangements for financing the extensions were practically settled. The completion of the scheme will give the company one of the finest steel-making and milling plants in the country. It possesses great local resources in raw materials, and excellent facilities for transport.

The Outlook.

In the lighter trades very mixed conditions have prevailed since the opening of the New Year. At present, there is less activity in saws, files, and edge tools than there was a month ago. The journal of the Sheffield Chamber of Commerce takes a hopeful view of trade prospects. While stating that Sheffield is not feeling the full effects of the improvement in the heavy and medium lines in the country as a whole, it goes on to say that both home and foreign orders for locomotives, steel rails, and general engineering products continue to broaden out steadily, and local steel makers will supply many of the necessary plates, castings, &c. "There will be a slightly better demand for ship steel and marine engineering castings shortly, in consequence of a few merchant and naval orders booked by shipbuilders, and we hear of plans to erect steel houses in some local colliery villages." The journal also states that the demand for stainless cutlery and other goods not only resulted in a record for 1925, but promises progressive expansion in 1926. Stainless steel continues to be put to an increasing number of uses, among which may be mentioned parts of stoves, ovens, cookers, fenders, fireguards, fire irons, bathroom fittings, perambulator parts, tramcar fittings, and horse gear.

Orders and Tenders.

Sheffield will benefit by the placing of orders for the two new cruisers for the Admiralty, which was announced last week. One order is to go to William Beardmore and Co., Ltd., Dalmuir, in which Vickers Ltd., of Sheffield, hold over 40 per cent. of the ordinary shares. Messrs. Vickers will also be directly engaged in the construction of the cruisers, as they have received orders for guns and armoury. A large dredger, capable of dredging to a depth of 40ft., for use at Hull, has been ordered by the London and North-Eastern Railway Company from Lobnitz and Co., of Renfrew. Sheffield firms have been invited to tender for steel carriage underframes for the South Indian Railway Company.

Mines Cementation.

The François Cementation Company, of Doncaster, whose process has been used with great success in overcoming water difficulties in the Doncaster coalfield has received two contracts of much interest. One of them is in connection with the making of the new Mersey Tunnel. The process will be employed in sealing up the fissures, and in the erection of a concrete lining, which is necessary before the steel shell of the tunnel can be placed into position by the engineers. The other contract which it is understood the company has accepted is for the sinking of a shaft at the Michael Colliery of the Wemyss Coal Company. The new colliery will be situated on the shores of the Firth of Forth, and, owing to the close proximity of the shaft to the sea, it is anticipated that considerable water difficulties may be experienced. Further, the colliery workings will extend underneath the sea, so that it is highly probable that the cementation process will be put to stiff tests.

Cutlery and Plate.

Somewhat better conditions are reported from several of the local factories, consequent on the placing of special orders. About half-a-dozen firms are sharing in valuable contracts for the equipment of steamships, hotels, and Pullman cars, with hollow-ware, knives, forks and spoons of high quality, and in these cases a state of activity prevails. Other orders for large quantities of goods are also on hand. General trade is quiet, and the electro-plate trade, as a whole, is depressed. As compared with a year ago, the output of spoons and forks is considerably down. Sales through the ordinary retail traders continue to decline, a fact which is in some quarters attributed to the large profits which many jewellers and ironmongers demand upon plate and cutlery. There is rather less than the average demand from the overseas markets. In stainless knives, prices are severely cut, and while the small makers, who offer cheap rates, are able to keep fully employed, the large firms are producing a much less bulk of goods than formerly. The trade in ordinary razors, which has been depressed for a long time, looks like benefiting considerably from the new safeguarding duty. It is stated that, in direct consequence of this impost, the largest order of recent times has just been booked. The new trade in safety razor blades is making rapid progress.

Coke Research at Sheffield.

An interesting addition to the industrial research work carried on at the University of Sheffield is an investigation regarding blast-furnace coke. An important Committee, to organise the research, has just been formed. It consists of representatives of the Midland and Lincolnshire Ironmasters' Associations and the Northamptonshire Blast-furnace Owners' Association, with Mr. W. J. Brooke, of Messrs. John Lysaght, Ltd., as chairman. The work is being carried out under the direction of Professors C. H. Desch and R. V. Wheeler in the Metallurgical and Fuel Laboratories of Sheffield University, where special apparatus has been installed. The first object is to identify and, it is hoped, specify those characteristics of different cokes which render them of greater or less value as blast-furnace fuels. Later—and for this work the co-operation of the coke manufacturers will be required—it will be necessary to investigate the means by which cokes of the required specification can be most readily and most economically made.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

THERE is a definite slackening of the demand in the iron and steel trades in the North of England at the moment, and market conditions have assumed a quieter tone than for some weeks past. Probably this is entirely due to apprehensions about the coal crisis, and the publication of the Coal Commission's report, which is expected next week, may do much to clear the air. Though the iron and steel works in this area are not running at anything like full capacity, plant that has been inoperative for some little time is gradually being restarted, and manufacturers consider the conditions may shortly justify firms running the greater part of their machinery. Certainly there is nothing in the general industrial situation to justify a pessimistic view. On the contrary, industrial demands show every sign of expanding, but consumers at the moment are inclined to caution.

Cleveland Iron Trade.

Business in the Cleveland pig iron trade is on a somewhat diminished scale, but this is attributed largely to the usual seasonal slackening, and the uncertainty regarding the coal trade position. The scarcity of pig iron is less acute, but supply is still barely sufficient to meet current needs, and producers are disinclined to make price concessions. The output of the two blast-furnaces rekindled last week is to be consumed by the firms producing the iron. Of the eighty odd blast-furnaces on the North-East Coast, forty-one are now in operation, thirteen of which are making Cleveland pig iron, thirteen hematite, and fifteen special kinds of iron. The system of fixed prices still prevails in regard to Cleveland foundry iron, and these prices are unchanged, No. 1 being 72s. 6d., No. 3 G.M.B. 70s., No. 4 foundry 69s., and No. 4 forge 68s. 6d. In the case of export orders 6d. per ton has to be added to the foregoing prices. There is, however, only a limited foreign demand, Cleveland prices being still substantially higher than those of foreign producers.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade is much easier. The demand is not so large and prices

have fallen 6d. per ton, mixed numbers becoming 77s. 6d. and No. 1 78s. per ton.

Iron-making Materials.

Foreign ore imports continue on a very heavy scale. Since the beginning of the year well over 300,000 tons have come into the river Tees. New business, however, is very scarce, and 21s. 6d. per ton is merely a nominal sellers' price for best Rubio ore. The coke market is weak, owing to the absence of export demand, and although sellers ask 20s. per ton delivered at the works, good Durham furnace coke might be bought at less.

Manufactured Iron and Steel.

A quieter feeling also prevails in the manufactured iron and steel trade. There is less foreign material offering and recent shipbuilding orders given out should improve the demand for plates and angles, but buyers seem to be hesitating, and most of the orders placed are for small quantities. There are, however, some big inquiries circulating for railway material for British Dominions, and if these should mature it would mean increased activity on the North-East Coast. Meanwhile, whilst manufacturers refuse to cut home quotations, good concessions are possible for export orders.

The Coal Trade.

The Northern coal trade has experienced a setback during the week. All sections of the market are dull, and there are scarcely any signs of renewal of demand. In these circumstances, prices show an easy tendency, and can, in favourable conditions as to shipment, be shaded. There is no strength in any department, and the month gives signs of ending without much prospective renewal in the demand. For the moment, consumers appear to have adequate supplies, and are disposed to hold off in view of possible lower values. Large steam coal business of any note is almost unheard of, and, with only a moderate number of prompt orders, sellers' positions grow less sure. Current quotations, though unchanged from last week, could possibly be varied in individual bargaining. Best Northumberland steam qualities continue at from 16s. 6d,. and secondary makes are easier at 15s. to 15s. 6d. Owing to the poor demand for steam smalls, producers are necessarily having to store their holdings, and quoted figures are weakly held. Bests are much the same at 8s. 9d. to 9s., seconds are easier at 8s. 3d. to 8s. 6d., and specials keep to 10s. to 10s. 6d. There is scarcely any movement towards new business in the Durham markets, and the tone generally is easier. Sellers are numerous, and buyers can obtain concessions. Best gas coals are fairly well held for prompt positions, with from 18s. to 19s. asked for good grades, but additional trade is not coming forward. Secondary gas coals are quoted up to 16s.; yet can be got down to perhaps 15s. 3d. Durham coking unscreened coals are badly wanting trade, and 15s. to 15s. 6d. is readily acceptable. Bunkers are unchanged at 15s. to 15s. 6d. for ordinaries and from 16s. to 17s. 6d. for bests and superiors. Although there is hardly any material change in the coke market, the tendency is none the less weakening. Still no improvement characterises the demand, and business is very small.

SCOTLAND.

(From our own Correspondent.)

Quiet Markets.

On the whole, business in the steel, iron and coal trades continues on quiet lines. The number of contracts for motor ships recently placed with Clyde shipbuilders has been increased by four during the past week, and optimism in industrial circles is further strengthened thereby. Time must elapse before the full benefit of these orders is apparent, but if the threatened trouble in the coal trade is averted and work in the shipyards and engineering shops proceeds without interruption, this optimism may be justified. Meanwhile, markets are not affected to any extent, buying generally being of a very restricted nature.

Pig Iron.

The turnover in the pig iron market continues on comparatively small lines. Sales are a shade better all round, but home demands are slow to expand. Prices are steady.

Steel.

A considerable proportion of the plants at the steel works is still out of action, but mills in operation are now gaining steadier orders for plates and sections. Keen competition is experienced, however, and prices are barely steady.

Steel Sheets.

Steel sheet makers are very busy. Light, black and galvanised sheets are in strong export demand; in fact, orders are outwith the expectations of makers, while home consumption also is heavy. The tone is very firm, and some makers have heavier bookings than they have known for a considerable time back. Heavy sheets are becoming more prominent.

Bar Iron.

The recent slight improvement in the bar iron trade is maintained. Though orders are only moderate, they are fairly regular, while in the re-rolled steel department of the industry a very fair turnover is reported. Here, again, keen competition is met with, and the price obtainable for re-rolled steel material is often barely remunerative.

Coal.

Conditions in the coal trade have changed completely within the past two weeks. During the latter half of January shippers bought large quantities of coal, presumably believing that the possibility of a strike of miners following the publication of the report of the Royal Commission would induce foreigners to anticipate future requirements, and lay in considerable stocks. Such expectations have not materialised, and the collieries, owing to the lack of stems for stipulated quantities, have been forced to dispose of considerable quantities of fuel at reduced prices. All descriptions of fuel are falling in price, with the possible exception of Ayrshire coal, which is fairly well booked for the Irish market. There is a scarcity of tonnage at the loading ports, which fact, of course, makes business still more difficult to negotiate. Aggregate shipments amounted to 245,024 tons, against 271,991 tons in the preceding week and 214,552 tons in the same week last year. The home market is quiet all round. Consumers have no difficulty in securing deliveries. Small stuffs, and drosses in particular, are very plentiful.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

There was a slight falling off in the coal exports from this district last week, as compared with the previous week, and it is just possible that the current week will show no improvement for the reason that tonnage shortage continues to be the trouble of most colliery undertakings. Tonnage has gone right out of position, and is proving very awkward for many undertakings. Whereas they were very fully sold for this month's shipment on paper, and would have been able to work with the utmost regularity had the tonnage come along to time, the position is such that many of them have had the greatest difficulty to avoid pit stoppages. In such circumstances the market has not displayed the steady tone that otherwise would have been the case. On the contrary, values have ruled easy for spot shipment, and irregularity has been much in evidence. The inquiry from abroad has also become quieter, which is not surprising in the case of France in view of the depreciation in the franc. Italy has not provided so much demand, but the situation there may change very quickly. In other directions no new business of any account has been concluded, and unfortunately it is reported that the order for the Belgian Congo Railway for 17,500 tons of patent fuel has been placed with Belgian manufacturers, while in the case of the French Marine, which was inquiring for 60,000 tons of Admiralty large, it is stated that the order has been withdrawn and French fuel ordered instead.

Cambrian Collieries Hitch.

Last week a settlement of the dispute, which has kept the Cambrian Collieries idle for eighteen months, was recorded, but unfortunately a resumption of work has been rendered impossible by the fact that nine enginemen concerned in the dispute have declined to agree to the terms. A statement issued by the men's Association states that the winding enginemen of the Clydach Vale Collieries are unanimously agreed upon the principle of a reduction for the sole purpose of an immediate restart of the collieries. They have offered the management that the basis of reduction as already agreed upon between the Miners' Federation, acting on behalf of the main haulage enginemen, shall also apply *pro rata* to the winding enginemen. The management has absolutely refused this and offers that the standard rate in future shall be 7s. 6d. in place of the standard rate of 8s. 11d., which has been paid at these collieries for the last forty years. The offer was refused by the winding enginemen. The consequence is that a deadlock prevails. The reply of the management is that the average rate per day of the winding enginemen in both the Rhonddas is 7s. 3·81d., whereas the nine enginemen concerned are offered 7s. 6d. per day, the highest rate paid throughout the valleys.

Dock Appliances.

One of four new movable hydraulic hoists erected at the Queen Alexandra Dock, Cardiff, came into operation last week for the first time. Two of these new appliances have an extreme height of 112ft. and the other two of 102ft. The capacity of load is 30 tons to lift and tip 20-ton capacity coal wagons, and the speed of the lift is 180ft. per minute. The motive power for travelling is provided by electricity, and the total weight of the hoist is 350 tons. The traversers, which are electrically driven, take one loaded and one empty wagon of 20 tons capacity, and there are tip-on and tip-off tables. The travelling speed is 230ft. per minute, and the carrying capacity is 40 tons. At its meeting at the end of last week the Newport, Chamber of Commerce passed a resolution that it considered that, owing to the fact that cranes at the Alexandra Docks, Newport, could not lift more than 30 tons, much heavy traffic was lost to the port, which in turn also led to the loss of other trade. One member pointed out that a 60-70-ton crane at least was required at Newport Docks to deal with general cargo traffic.

Cardiff City's Engineer.

Mr. T. Peirson Frank, the Cardiff City engineer, has been selected as city engineer for Liverpool. Mr. Frank has been in his present position since May, 1923, when he succeeded Mr. E. J. Elford. Prior to that he was for 3½ years the borough engineer and surveyor at Plymouth. There were forty-five applicants for the Liverpool post, which carries £2000 per annum.

Steel Contract.

It is announced that the Ebbw Vale Steel, Iron and Coal Company has been awarded the third contract for the supply of 100,000 steel sleepers for the Egyptian State Railways, the price being £53,670—Egyptian sterling.

Death of Well-known Business Man.

Following an operation some days ago, the death took place on Wednesday morning of Mr. W. Southwell Jones, who was deputy chairman of L. Gueret and Co., Ltd., and director of several associated companies and the North British and Mercantile Insurance Company, Ltd.

Current Business.

New business for current shipment has not been active during the past week. Very few have been in a position to take advantage of the weakness which has prevailed for most descriptions of coal for prompt loading. This weakness has been brought about by the absence of an adequate supply of ready tonnage. Most steamers chartered during the past fortnight have been delayed by the bad weather, and their failure to turn up to time has caused most collieries great inconvenience. The result is that the collieries have been pressing their contractors to give them prompt boats to ship coals due to them. Prompt steamers, however, have been at a premium. Colliery salesmen have been ready to make concessions of 6d. per ton in their prices to those buyers able to take quick delivery. Small coals have weakened to a relatively greater extent than large coals. Patent fuel keeps very steady, and most of the works are better employed. Pitwood is very firm and nominally around 40s. to 42s. 6d. The strike of workers at Bordeaux has extended to Pauillac, and it is considerably interfering with the supplies of pitwood coming forward from France.

Later.

The strike of pitwood workers at Bordeaux and Pauillac is now reported to have spread to Bayonne and Blaye, which will further restrict the shipment of supplies to South Wales. If the stoppage is prolonged it is greatly feared that the shortage of pitwood will adversely affect work at South Wales pits.

CATALOGUES.

Herbert Morris, Ltd., Loughborough.—Book 101, dealing with the Norris electric runway.

British Insulated Cables, Ltd., Prescot, Lancs.—Mining cables and accessories catalogue.

Edgar Allen and Co., Ltd., Imperial Steel Works, Sheffield.—Second edition of "Carbon Tool Steels."

Henry Brice and Co., 37, Jewry-street, E.C. 3.—Booklet on M.W.M.—formerly Benz—Diesel engines.

J. Hopkinson and Co., Ltd., Britannia Works, Huddersfield.—List No. 1860, dealing with draught gauges.

R. Jenkins and Co., Ltd., Rotherham.—Booklet, containing some examples of welding jobs carried out by the firm.

The Marconiphone Company, Ltd., 210-212, Tottenham Court-road, W. 1.—Copies of the Marconiphone log book.

Victoria Bridge Engineering Works, Ltd., Bridge-road, Stockton-on-Tees.—Leaflet describing a new interlocked steel.

Nobel Industries, Ltd., Nobel House, Buckingham-gate, S.W. 1.—Brochure, entitled "The Products of Nobel Industries, Ltd."

George Cohen Sons and Co., Ltd., 600, Commercial-road, E. 14.—Illustrated leaflets and booklet of plant and machinery for sale.

James Keith and Blackman Company, Ltd., 27, Farringdon-avenue, E.C. 4.—Booklet K 1, describing the "Keith" centrifugal fan.

Alfred Herbert, Ltd., Coventry.—Brochure entitled "The Proof of the Pudding," containing a number of testimonials from customers.

Fullers United Electric Works, Ltd., Woodland Works, Chadwell Heath, Essex.—Catalogue No. 170, dealing with train-lighting batteries.

The General Electric Company, Ltd., Magnet House, Kingsway, W.C. 2.—Revised edition of the electric lighting supplies catalogue.

David Brown and Sons (Huddersfield), Ltd., Park Works, Lockwood, Huddersfield.—Booklet, entitled "Modern Case-hardening Practice."

Hans Renold, Ltd., Didsbury, Manchester.—Publication dealing with a comprehensive range of standard chain drives available from stock.

The United Steel Companies, Ltd., Sheffield.—Booklet showing the types of railway materials made and a list of steels giving their properties.

The Ransome and Marles Bearing Company, Ltd., Newark-on-Trent.—Service booklet, containing size and price lists of ball and roller bearings.

Norris, Henty and Gardners, Ltd., Patricroft, Lancs.—Catalogue No. 506, describing the V.T. vertical single and double-cylinder heavy-oil engine.

The Consett Iron Company, Ltd., Consett, Co. Durham.—Leather-bound sectionalised catalogue, containing particulars of the company's products.

The Ransome Machinery Company (1920), Ltd., 42-50, Victoria-street, S.W. 1.—Catalogue No. 43, describing in detail the Ransome 1925 type asphalt plant.

Insulating Materials.—The attention of the British Electrical and Allied Industries Research Association has been called to the possibility of confusion arising through the use in its reports of letters of the alphabet for the classification of certain insulating materials, according to properties, uses, &c., because of the fact that the British Engineering Standards Association has adopted a classification of insulating materials used in electrical machinery and apparatus by letters of the alphabet according to the working temperatures for which they are suitable. In consultation with the B.E.S.A., it has been decided that this Association shall in future use Roman numerals for its classifications, and thus avoid any clashing with the classifications of the B.E.S.A. The following reports already issued are affected by this alteration:—Ref. A/S 3, Pressboard; Ref. A/S 5, Insulating Papers; Ref. A/S 10, Non-ignitable Boards. In all the above documents where the classification is Class A, Class B, Class C, &c., the designation in future will be Class I., Class II., Class III., &c.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
Native	21/-
(1) Spanish	18/6
(1) N. African	18/6
N.E. COAST—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 17 0	—
No. 1 Foundry	3 19 0 to 4 1 6	
No. 3 Foundry	3 16 6 to 3 19 0	
N.E. COAST—		
Hematite Mixed Nos.	3 17 6	3 17 6
No. 1	3 18 0	3 18 0
Cleveland—		
No. 1	3 12 6	3 13 0
Silicious Iron	3 12 6	3 13 0
No. 3 G.M.B.	3 10 0	3 10 6
No. 4 Foundry	3 9 0	3 9 6
No. 4 Forge	3 8 6	3 9 0
Mottled	3 7 6	3 8 0
White	3 7 6	3 8 0
MIDLANDS—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 5 0	—
,, Forge	2 16 0 to 2 17 6	
(3) Derbyshire—		
No. 3 Foundry	3 7 6	-
Forge	3 2 0 to 3 3 0	
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 6	—
Basic	3 6 0	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 10 0 (a) / 4 12 6 (b) / 4 17 6 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	11 5 0	—
Best	—	—
N.E. COAST—		
Common Bars	11 0 0	—
LANCS.—		
Crown Bars	11 10 0 to 11 15 0	
Second Quality Bars	10 15 0 to 11 0 0	
Hoops	15 0 0	—
S. YORKS.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
MIDLANDS—		
Crown Bars	11 0 0 to 12 0 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 5 0 to 11 0 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates	11 0 0	—
Ship Plates, ¼in. and up.	7 10 0	—
Sections	7 0 0	—
Steel Sheets, under 3/16in. to ¼in.	9 0 0	—
Sheets (Gal. Cor. 24 B.G.)	—	£17 to £18

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E COAST—		
Ship Plates	7 7 6	—
Angles	7 0 0	—
Boiler Plates	11 10 0	—
Joists	7 0 0	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 0 0†	—
Light ,,	8 5 0 to 8 10 0	
Billets	7 10 0 to 9 0 0†	
MANCHESTER—		
Bars (Round)	8 5 0 to 8 15 0	
,, (others)	8 0 0 to 8 10 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	7 17 6 to 8 5 0	
,, (Lancs. Boiler)	11 10 0	—
SHEFFIELD—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	6 15 0 to 7 0 0	
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
MIDLANDS—		
Small Rolled Bars	7 17 6 to 8 0 0	
Billets and Sheet Bars	6 2 6 to 6 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 0 0 to 16 5 0	
Angles	7 2 6 to 7 5 0	
Joists	7 2 0 to 7 5 0	
Tees	8 2 6 to 8 5 0	
Bridge and Tank Plates	7 17 6 to 8 0 0	
Boiler Plates	11 0 0 to 11 10 0	

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14	19 3 to 19/6
Block Tin (cash)	294 7 6
,, (three months)	283 15 0
Copper (cash)	59 17 6
,, (three months)	60 16 3
Spanish Lead (cash)	33 15 0
,, (three months)	33 18 9
Spelter (cash)	35 15 0
,, (three months)	35 16 3
MANCHESTER—	
Copper, Best Selected Ingots	65 10 0
,, Electrolytic	66 15 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
,, Condenser	0 1 2½
Lead, English	37 0 0
,, Foreign	36 0 0
Spelter	38 0 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/1 to 2/2 per lb.	
Ferro Tungsten	1/11 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£22 0 0	8/-
,, 6 p.c. to 8 p.c. ,,	£22 0 0	7/3
,, 8 p.c. to 10 p.c. ,,	£21 0 0	7/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£40 0 0	14/-
,, ,, 1 p.c. ,,	£46 0 0	15/6
,, ,, 0·70 p.c. carbon	£56 0 0	17/6
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	3/6 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 0 0 scale 5/- per unit	
,, ,, 75 p.c.	£21 0 0 scale 6/- per unit	
,, Vanadium	14/- to 15/- per lb.	
,, Molybdenum	6/- per lb	
,, Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£172 to £175	
Cobalt	10/- per lb.	
Aluminium (per ton)	£120	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	16,6
,, ,, Ell	16/3
,, ,, Splint	18,6 to 21/6
,, ,, Trebles	16/-
,, ,, Doubles	15/3
,, ,, Singles	12/9
AYRSHIRE—	
(f.o.b. Ports)—Steam	16/6
,, ,, Jewel	17/-
,, ,, Trebles	17/-
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	12/6 to 15/6
Screened Navigation	21/-
Trebles	17,6 to 18/6
Doubles	14/9
Singles	12/9
LOTHIANS—	
(f.o.b. Leith)—Best Steam	14/6
Secondary Steam	13/9
Trebles	15/6
Doubles	14/9
Singles	13/-

ENGLAND.

(8) N.W. COAST—	
Steams	24/6
Household	40/- to 48/-
Coke	26/6
NORTHUMBERLAND—	
Best Steams	16,6 to 17/-
Second Steams	15/6 to 16/-
Steam Smalls	9/-
Unscreened	14/-
Household	20/- to 22/-
DURHAM—	
Best Gas	18/-
Second	16/- to 16,3
Household	20/- to 22/-
Foundry Coke	19/- to 21/-
SHEFFIELD—	Inland.
Best Hand-picked Branch	31/- to 34/-
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	28/- to 28/- —
,, ,, House	24/- to 25/- —
,, ,, Large Nuts	17/- to 20/- —
,, ,, Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire ,,	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty ,,	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
,, ,, (Export)	f.o b. 19/- to 20/-

(9) SOUTH WALES.

CARDIFF—	
Steam Coals:	
Best Smokeless Large	23/- to 24/-
Second ,, ,,	21/6 to 22/6
Best Dry Large	21/- to 22/-
Ordinary Dry Large	20/- to 20/6
Best Black Vein Large	21/- to 21/6
Western Valley Large	20/- to 21/-
Best Eastern Valley Large	20/- to 20/6
Ordinary ,, ,,	19/- to 20/-
Best Steam Smalls	12/6 to 13/-
Ordinary ,,	11/- to 12/-
Washed Nuts	19/- to 29/-
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	16/- to 17/-
No. 2 ,, Large	19/6 to 20/6
,, ,, Through	16/- to 17/-
,, ,, Smalls	10/6 to 11/-
Foundry Coke (export)	37/6 to 40/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	20/- to 22/6
Pitwood (ex ship)	40/- to 42/6
SWANSEA—	
Anthracite Coals:	
Best Big Vein Large	40/- to 42/6
Seconds	33/- to 35/-
Red Vein	27/- to 30/-
Machine-made Cobbles	52/6 to 55/-
Nuts	52/6 to 55/-
Beans	42/6 to 45/-
Peas	21/- to 24/-
Breaker Duff	7/- to 7/6
Rubbly Culm	8/9 to 9/6
Steam Coals:	
Large	22/- to 23/6
Seconds	20/- to 22/-
Smalls	9/- to 10/-
Cargo Through	16/- to 17/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market, 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

The Trade Future.

THE price of coke has been further advanced and pig iron values have increased to a corresponding extent. Rolled iron and steel quotations are to be raised. The balance of trade, as shown by the monthly returns, is unfavourable, and the tendency observable at the end of last year towards increasing imports and diminishing exports has become accentuated. All this accompanies a continuous decline in the value of the franc, which has fallen to a further record level. Now that the importance of the exchange rate is fully recognised, no one has any confidence in the future until something is done to bring the franc back to a level at which it can be conveniently stabilised. The only hope of this being done lies in the carrying out of an acceptable financial programme, but so far all efforts to ensure a general and equitable system of taxation have failed, and the manufacturing industries are still threatened with a 30 per cent. increase in import duties, a tax on exports, and a tax on payments. The proposed increase of import duties is unpopular because it is not needed by manufacturers and will have no other effect but to enhance the cost of raw material and to raise prices on the home market. For the moment everyone is maintaining an attitude of reserve, except buyers of iron and steel, who are anxious to place orders in view of further advances in prices which appear inevitable, but mill and forge owners, who have their books well filled for the next three months, are very reluctant to increase their commitments. Under these conditions French producers desire to provide against a possible collapse following upon further violent fluctuations in currency by coming to an understanding with other continental firms for regulating the production and maintaining prices. This has already been done in the case of pig iron by a sort of informal agreement between French, Belgian, and Luxemburg producers. Further efforts are now being made to create an international rail trust.

Port of Rouen.

The total amount of traffic at the port of Rouen in 1925 was 6,943,000 tons, or nearly 900,000 tons less than in 1924 and two million tons less than in 1923. This decline was due almost entirely to the smaller consignments of British coal, which only reached a total of 2,559,313 tons. The quantity of German coal unloaded was 1,266,447 tons, or more than half a million tons in excess of the total for the previous year. For the first time the tonnage carried by French boats exceeded that of the British. The heavy decline of traffic caused a corresponding reduction in revenue, which has had the effect of retarding the execution of the programme for making Rouen one of the best-equipped ports in the country. Nevertheless, a great deal of work has been carried out, and the electrical equipment for unloading coal at a wharf 628 m. long is now practically completed. Sixteen 5-ton electric cranes have already been installed and three others are awaiting delivery. The scheme for the extension of port facilities also aims at bringing oil tank steamers to Rouen, and the construction of a wharf beyond the existing one on the right bank of the river will accommodate the largest vessels that can come up the Seine. In view of the huge amount of grain that was unloaded at Rouen during the war, it was hoped subsequently to attract the grain traffic by installing a particularly complete equipment for the pneumatic unloading of grain ships and the automatic weighing into sacks, but during the past year the results did not come up to expectations, although it is hoped that the efforts being made to divert a part of the grain traffic through Rouen will prove successful. In view of its situation as a port of transit to Paris by the Seine, Rouen was able to rival Marseilles as the leading port as regards tonnage, so long as it could rely upon British coal traffic, and the Rouen Chamber of Commerce still hopes to recover lost ground by offering facilities for the transit of oil, grain, timber and wine.

Foreign Trade.

A large increase in the values of imports and a diminution in the tonnage of exports are the inevitable consequences of the currency depreciation which is now beginning to have effects entirely different from those that were at one time regarded as particularly favourable to foreign trade development. So long as the country was, to a large extent, living upon accumulated stocks, it was able, with its depreciated money, to sell in foreign markets at low prices, but larger quantities of raw material have now to be purchased abroad and much higher prices in French currency have necessarily to be paid for them. Thus in January the total value of imports was 4483 million francs, or 1319 million francs more than in the first month of 1925. The import tonnage amounted to 3,629,359 tons, an augmentation on the year of 110,806 tons. The export values in January were estimated at 3868 million francs, an increase of 317 million francs. The tonnage amounted to 2,271,275 tons, a diminution as compared with January of last year of 5436 tons, so that while paying more dearly for their raw material, French producers had to sell abroad at higher prices. Notwithstanding this, the exports of manufactured goods, amounting to 337,324 tons, showed an increase of 64,789 tons.

The French Navy.

As a means of ensuring the voting of credits for naval construction a great deal is being made of the precarious situation in which France is placed in the Mediterranean by the alleged superiority of the Italian navy, to say nothing of the British naval forces, which, in the words of the President of the Senatorial Commission of the Marine, constitute "the most formidable armada the world has ever seen." All this is intended to accelerate the execution of the shipbuilding programme, and the Minister of Marine is asking Parliament for the credits necessary for the construction of a cruiser and a submarine at Cherbourg, a submarine and a minelayer at Lorient, and a submarine at Toulon.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

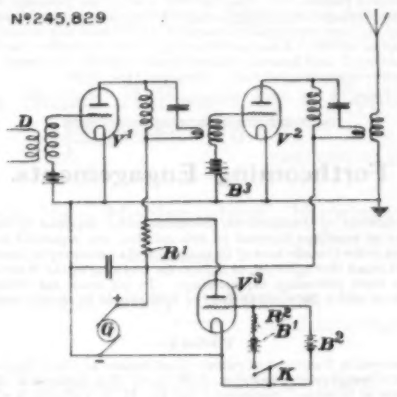
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TELEGRAPHS AND TELEPHONES.

245,829. October 13th, 1924.—IMPROVEMENT IN WIRELESS TRANSMITTING APPARATUS, Normal Eustace Davis, of "Carn," Marth, 42, Park-avenue, Chelmsford, Essex, and William Theodore Ditcham, of Middleton House, Victoria-road, Colchester, Essex.

This invention is particularly applicable to wireless transmitters using high powers and for transmitting signals at high speeds. In the diagram D represents the independent drive circuit coupled to the grid circuit of the intermediate magnifier V^1, the plate circuit of which is coupled to the grid circuit of the final magnifier V^2. The aerial is energised by induction from the plate of the amplifier V^2. G is a generator supplying the plate potentials of the amplifiers V^1 and V^2, the latter directly and the former through a resistance R^1. Connected across the resistance R^1 and the generator G is an absorber comprising a valve V^3, batteries B^1 and B^2, a resistance R^2 and switch K, which may conveniently be a Morse signalling key, arranged and connected as shown so that operation of the switch will change the potential of the grid of the valve from positive to negative, or *vice versâ*.

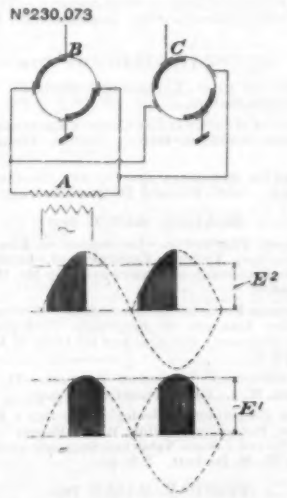


When the grid of the valve V^3 is positive there will be a considerable drop of potential across the resistance R^1, owing to the current taken by the absorber circuit, and the potential applied to the plate of V^1 will therefore be considerably reduced. The switch K therefore serves to control the output from the valve V^1 and the amplitude of the oscillations of the main amplifier V^2. B^2 is a battery connected in the grid lead of the main amplifier V^2, so as to apply a degree of negative bias thereto. This fixed negative bias is preferably of such value that when the absorber is rendered conductive and the oscillations of the intermediate magnifier thereby reduced to zero the anode current of the main valves will cease. By suitably proportioning the resistance and absorber any required fraction of the full load may be taken from the high-voltage source and used up in the resistance during the time the absorber grid is positive, thus preventing voltage surges and variations in the supply circuits when signalling. It is clear that the above described arrangement may equally well be applied to the independent drive, if this circuit is supplied from the same source of high voltage as the magnifier valves.—*January 13th*, 1926.

TRANSFORMERS AND CONVERTERS.

230,073. February 25th, 1925.—METHOD OF AND MEANS FOR OPERATING MECHANICALLY DRIVEN RECTIFIERS IN CONNECTION WITH ELECTRIC TRANSFORMERS, *Lodge-Cottrell, Ltd., of 51, Great Charles-street and Church-street, Birmingham.*

This invention relates to a method of obtaining from one electrical transformer working in conjunction with synchronously



rotating mechanical rectifiers two or more uni-directional currents at potentials of different magnitudes. In the upper drawing A represents a high-tension transformer which works in conjunction with two synchronously rotating mechanical rectifiers B and C. The stationary contacts of the first rectifier are shown in the normal position for collecting the current at the peak position of the alternating-current sine wave, and one of the contacts is shown connected to earth, which serves as the return circuit in the usual manner. The rectified current delivered at B is shown diagrammatically in the lower illustration, where the height E^1 represents the R.M.S. value of the current. If one or more additional rectifiers rotating in synchronism with the first rectifier are connected to the same transformer, and if their stationary contacts are displaced from the position occupied by those of the first rectifier, as shown in the upper illustrations, then the current collected by these contacts and delivered at E^2 is of a lower potential than that in the first case. Such a current is shown graphically in the middle illustration, where the height E^2 represents the R.M.S. value of the current. The shaded portions of the drawings indicate those parts of the alternating-current sine wave which are tapped by means of the stationary contacts. It is thus possible to obtain from one transformer two or more uni-directional currents at potentials of different magnitudes. The scheme is advantageous when a transformer is used to supply power to two or more precipitators which serve different purposes and which may work at different potentials or in the case of an electrical gas purifier, consisting of two or more sections working at different potentials.—*January 14th*, 1926.

PUMPING AND BLOWING MACHINERY.

245,979. April 2nd, 1925.—CONTROLLING GEAR FOR AIR COMPRESSORS, *E. C. R. Marks, 57, Lincoln's Inn-fields, London, W.C. 2.*

This is a device for unloading an air compressor when the air pressure in the receiver reaches the working limit, and it is claimed that it works more gently, especially when the machine is run at a high speed, than the generality of such devices. The inlet valve A of the compressor is of normal type, but can be held off its seating by the fork B, which may be pressed down by air

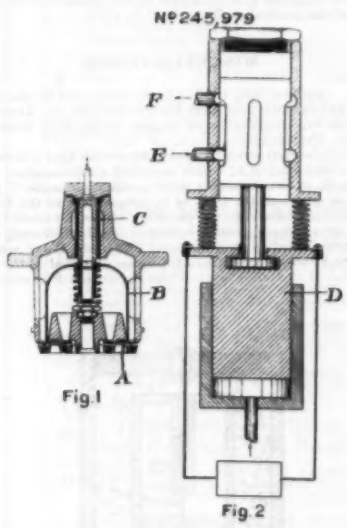


Fig. 1

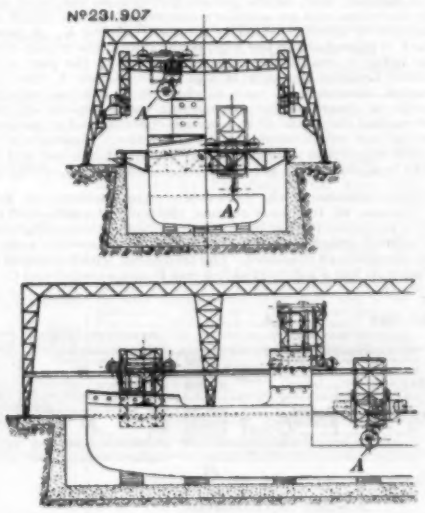
Fig. 2

pressure acting above the piston C. The supply of pressure air for this purpose is taken from the delivery pipe of the compressor, but is passed through a throttling valve, as shown in Fig. 2, on its way. In this valve the piston D is subject to the pressure in the receiver and it controls the flow through the pipes E F which form part of the connection with the piston C, Fig. 1. The result is that the inlet valve A is held off its seating during that part of the compression stroke which is not necessary for maintaining the pressure in the receiver.—*January 21st*, 1926.

MACHINE TOOLS AND SHOP APPLIANCES.

231,907. April 7th, 1925.—DEMOLISHING SHIPS, *A. E. Beck, 115, Cannon-street, London, E.C. 4.*

This invention is put forward as being especially applicable to the breaking up of obsolete ships, but it is obvious that it could be used for various other purposes. The cutting is effected



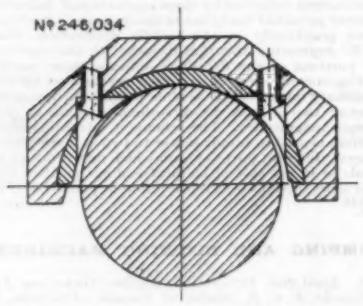
by high-speed friction discs A A mounted on travelling frames. It is said that in some circumstances it may be an advantage to supply a small stream of oxygen at the point where the cutting disc is working. The inventors claim that the process is much less costly than blow-pipe cutting.—*January 14th*, 1926.

TRAMWAYS AND RAILWAYS.

246,034. July 10th, 1925.—AXLE-BOXES, Eisen- und Stahlwerke Walter Peyinghaus, Egge, near Volmarstein-on-the-Ruhr, Germany.

This invention refers to the type of bearing which embraces the upper half of the journal, the inner diameter thereof being

made greater than the diameter of the journal, so that it does not bear tightly laterally against the journal; that is to say, there is a space left between the journal and the inner diameter of the bearing. Hitherto, it is claimed, the construction of this type of bearing has precluded it from being used for upper side lubrication of the journal, since it would result in the oil adhering to the sides of the grooves in the brass, flowing down therethrough,

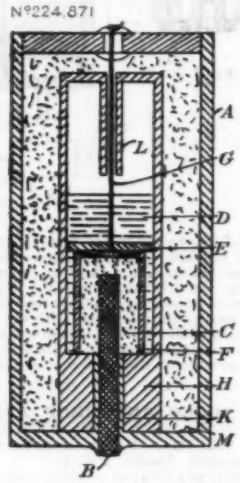


and dripping off the edge without reaching the journal; hence with this type of bearing it is usual to employ underside lubrication. According to the invention a bearing of this type is adapted for upper-side lubrication by the provision of oil conducting passages therein, which are provided with feeding tubes having extended discharge edges directed towards the axle journal, so that the lubricant can be fed positively to the upper surface of the journal.—*January 21st*, 1926.

MISCELLANEOUS.

224,871. October 7th, 1924.—IMPROVEMENTS IN OR RELATING TO APPARATUS FOR THE RECTIFICATION OF ALTERNATING CURRENT, Henri Georges André, of 10, Rue Rodier, Paris (IXe), France (Seine).

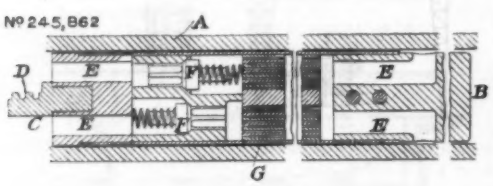
A rectifier constructed in accordance with this invention consists of a lead casing A, which contains an aluminium or nickel electrode B, in close contact with a colloidal anode C, prepared with silver or graphite, that is in suspension in the electrolyte D, which penetrates into the chamber of the electrode C through a porous membrane made of asbestos or other filtering material. The current reaches the colloidal electrode C by way of the conductor F, which may be of the same material as the colloidal anode, but in the solid state. The conductor F is connected to



the outside of the rectifier by an inert wire G, which is soldered to a contact stud, which passes through an insulated plug. The electrodes and an auxiliary electrolyte are contained in a glass tube H which is sealed by means of sulphur K. A narrow tube L is placed above the level of the liquid, the object of this tube being to enable the gases to escape. In the part of the rectifier between the tube H and the container A there is a chemical substance M, such as chloride of calcium, which is capable of absorbing the surrounding water vapour and thus ensures that the liquid D will remain concentrated if the liquid used is one which tends to absorb water. Apparently the rectifier requires to be heated before putting it into use, and two methods of doing this are described.—*January 7th*, 1926.

245,862. October 20th, 1924.—HOT AIR ENGINES, J. F. J. Malone, 86, Rothbury-terrace, Heaton, Newcastle-on-Tyne.

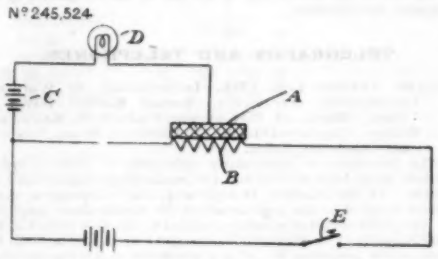
This invention is what might be described as the application of the uniflow principle to hot air engines, in connection with the heat transferer or displacer. The transferer, which slides in the cylinder A, has a substantial hot end B and a cooled end C. It



is connected with the crank shaft of the engine by means of the rack D and a pinion not shown. The passages E E for the transfer of the working gas from one end to the other are controlled by the non-return valves F F and about their middle portion are formed as narrow annular spaces G, which are specially favourable to the transfer of heat from the hot to the cold side.—*January 20th*, 1926.

245,524. October 10th, 1924.—IMPROVEMENTS RELATING TO ELECTRICAL THERMO-SENSITIVE APPARATUS, *The Westinghouse Brake and Saxby Signal Company, Ltd., of* 82, *York-road, King's Cross, London.*

This invention relates to thermo devices which depend for their action upon a change in a characteristic of an element in response to changes in the temperature. The object is to provide an improved device of this nature in which the heater elemen causing the change in the temperature of the heated element is composed of a material having a temperature coefficient selected to neutralise, reduce or amplify the effect of variations in the voltage i: pressed upon the heater element circuit, thus enabling a corresponding predetermined control to be imposed upon the circuit containing the heated element. In the drawing A is a thermo sensitive element which varies its electrical resistance in response to variations in the temperature of the element. This element has a negative temperature coefficient, the substance used being, for example, copper oxide. B is the heating element, supplied with current in the manner indicated. In the thermo-electric element circuit is a source of energy C and a current-consuming device D, such as a lamp. The parts are



so proportioned that the resistance of the thermo-sensitive element A is normally too large to permit enough current to pass to light the lamp. If, however, the lower circuit is completed at E, the heat from the element B raises the temperature of the element A, thereby reducing its resistance and allowing the lamp D to light. No hint is given in the specification as to what purpose the invention is to be applied, but reference is made to a previous patent, viz., No. 199,480, which may possibly throw light on the matter. It is pointed out that the consuming device D may be any electrically operated device and not necessarily a lamp as shown. In a modification of the invention the lamp D, battery C and heated element A are entirely insulated from the lower energising circuit.—*January 11th*, 1926.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

CHADWICK PUBLIC LECTURE.—Institution of Civil Engineers, Great George-street, London, S.W. 1. "The Activated Sludge Process of Sewage Treatment," by Dr. H. T. Calvert. 8 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers' Club, Coventry-street, London, W. 1. Paper, "Signalling from a Driver's Point of View," by Mr. W. J. Thorrowgood. 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Sackville-street, Manchester. Paper, "Locomotive Built-up Cranks," by Mr. G. N. Shawcross. 7 p.m.

INSTITUTION OF PRODUCTION ENGINEERS.—Society of Motor Manufacturers, 83, Pall Mall, London, S.W. 1. Debate on "Payment by Results." 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Lecture, "Seven Thousand Years of Shipping," by Mr. J. F. Petree. 7.30 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—Literary and Philosophical Society's Lecture Theatre, Newcastle-upon-Tyne. Paper, "Hydro-mechanical Gearing," by Mr. James Richardson. 7.30 p.m.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, London, S.W. 7. Papers: "The Effects of Torsion upon the Thermal and Electrical Conductivities of Aluminium, with special reference to Single Crystals," by Mr. J. E. Calthrop; "A Study of the Concurrent Variations in the Thermionic and Photo-electric Emission from Platinum and Tungsten with the State of the Surfaces of these Metals," by Mr. T. H. Harrison; Demonstrations of some Phenomena of Surface Tension will be given by Mr. Edwin Edser and by Mr. Charles R. Darling. 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Nicolas de Peiresc and his Circle," by Dr. C. Hagberg Wright. 9 p.m.

UNIVERSITY COLLEGE ENGINEERING SOCIETY.—The Refectory, University College, Gower-street, London, W.C. 1. Annual Dinner.

SATURDAY, FEBRUARY 27TH.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to the Northolt Wireless Station.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Council House, Bishops Stortford, Herts. Eastern District meeting. 2.15 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Town Hall, Bridport. South-Western District meeting. 2 p.m.

MONDAY, MARCH 1ST.

INSTITUTE OF TRANSPORT.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "State Ownership of Waterways," by Mr. H. D. Dickinson. 5.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: WESTERN CENTRE.—South Wales Institute of Engineers, Park-place, Cardiff. Paper, "The Engineer: His Due and his Duty in Life," by Mr. T. Carter. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. General meeting. 5 p.m.

SOCIETY OF ENGINEERS.—Geological Society's Rooms, Burlington House, Piccadilly, London, W. 1. Paper, "Tidal Power on the River Severn: Some Notes and Suggestions on its Utilisation," by Mr. W. M. Beckett. 5.30 p.m.

TUESDAY, MARCH 2ND.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower Hill, London, E. 1. Paper, "Electrical Deck Machinery," by Mr. J. Mansel Lewis. 6.30 p.m.

INSTITUTE OF METALS: BIRMINGHAM LOCAL SECTION.—Chamber of Commerce, New-street, Birmingham. Paper, "Light Alloys," by Dr. L. Aitchison. 7 p.m.

INSTITUTE OF METALS: NORTH-EAST COAST LOCAL SECTION.—Electrical Engineering Lecture Theatre, Armstrong College, Newcastle-upon-Tyne. Paper, "Bearing Metals," by Mr. R. T. Rolfe. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Broadgate Café, Coventry. Coventry Graduates' meeting. Paper, "Some Problems we Meet," by Mr. L. H. Dawtrey. 7.15 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Annual general meeting followed by ordinary meeting. 6.50 p.m.

WEDNESDAY, MARCH 3RD.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Cavendish Café, Cornmarket, Derby. Derby Graduates' meeting. Paper, "Permanent Mouldings and Die Castings," by Mr. L. A. Selvey. 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Informal meeting. Discussion on "Road Construction," introduced by Mr. H. E. Lightfoot. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Wireless Section meeting. Papers: "The Directional Recording of Atmospherics," by Mr. R. A. Watson Watt: and "An Instantaneous Direct Reading Radiogoniometer," by Messrs. R. A. Watson Watt and J. F. Herd. 6 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "Science in the Cable Industry," by Mr. P. Dunsheath. 8 p.m.

THURSDAY, MARCH 4TH.

INSTITUTION OF ELECTRICAL ENGINEERS.—Savoy-place, Victoria Embankment, London, W.C. 2. Paper, "Electro-farming, or the Application of Electricity to Agriculture," by Mr. R. B. Matthews. 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Atom of Light and the Atom of Electricity, II.," by Dr. C. D. Ellis. 5.15 p.m.

FRIDAY, MARCH 5TH

INSTITUTION OF CIVIL ENGINEERS: BIRMINGHAM AND DISTRICT ASSOCIATION.—Chamber of Commerce, New-street, Birmingham. Paper, "Sewage Disposal," by Mr. J. B. Mayers. 6 p.m.

JOINT DELEGATIONS OF THE YORKSHIRE ASSOCIATIONS OF THE INSTITUTIONS OF CIVIL, MECHANICAL, ELECTRICAL, MUNICIPAL AND COUNTY, AND LOCOMOTIVE ENGINEERS.—Great Northern Hotel, Leeds. Dinner. 6.30 for 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Paper, "Tendencies in Modern Electric Practice," by Mr. J. M. Seddon. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—The Engineers' Club, Waterloo-street, Birmingham. Paper, "Hoisting Appliances," by Mr. C. H. Woodfield. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "London Traffic," by Sir Henry Maybury. 9 p.m.

SATURDAY, MARCH 6TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Manchester. Lecture, "Aluminium Foundry Practice," by Mr. G. Mortimer. 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. "The Rare Gases of the Atmosphere," by Sir Ernest Rutherford. 3 p.m.

MONDAY, MARCH 8TH.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Annual general meeting. Paper, "Nickel and its Alloys," by Mr. W. R. Barclay. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM CENTRE.—Chamber of Commerce, Birmingham. Paper, "The Metallurgist in Inspection and Design," by Mr. Topliss. 7 p.m.

TUESDAY, MARCH 9TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal College, Ormerod-road, Burnley. Paper, "The Usefulness of Wood Patterns Mounted on Boards," by Mr. A. E. Wilson. 7.15 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: COVENTRY CENTRE.—Broadgate Café, Coventry. Paper, "The Preparation of Motor Cycles for Speed Events," by Mr. P. Brewster. 7.30 p.m.

WEDNESDAY, MARCH 10TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Micro-structure of Coal," by Dr. Reinhardt Thiessen. 8 p.m.

WEDNESDAY AND THURSDAY, MARCH 10TH AND 11TH.

INSTITUTE OF METALS.—Institution of Mechanical Engineers, Storey's-gate, Westminster, London, S.W. 1. Annual general meetings. 10 a.m. each day. For programme see page 222.

FRIDAY, MARCH 12TH.

INSTITUTE OF METALS: SWANSEA LOCAL SECTION.—Metallurgical Department, University College, Singleton Park, Swansea. Discussion on "Annealing." 7.15 p.m.

MONDAY, MARCH 15TH.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "Thermometry, I.," by Mr. W. F. Higgins. 8 p.m.

TUESDAY, MARCH 16TH.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Applied Science Department of the University, St. George's-square, Sheffield. Paper, "Aluminium: Where and how it is Made," by Mr. G. B. Brook. 7.30 p.m.

THURSDAY, MARCH 18TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Institute of Marine Engineers, 85–88, The Minories, London, E. 1. Paper, "The Preparation and Structure of Wires of Pure Tungsten," by Dr. C. J. Smithells. 7.30 p.m.

EMPIRE MINING AND METALLURGICAL CONGRESS, 1927.—The Empire Council of Mining and Metallurgical Institutions—Cleveland House, 225, City-road, London, E.C. 1—on behalf of the ten constituent bodies, has accepted the invitation of the Canadian Institute of Mining and Metallurgy to hold the Second Empire Mining and Metallurgical Congress in Canada in August–September, 1927. Further particulars will be announced later.

I.E.E. MODEL FORM OF GENERAL CONDITIONS "A."—Clause 37 (Regulations of Local Authorities) of the edition (revised September, 1921) has been amended by the Council to make it clear that the regulations and by-laws with which the contractor shall conform are those which the local or other authorities are authorised by statute to make. In Clause 37 of the new edition (revised January, 1926) the words "which they are authorised by statute to make and" have been inserted after the word "Authorities." The new edition in all other respects conforms with the old edition.